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EDITOR'S OUTLOOK

THE Nobel prize in chemistry for 1921 was awarded to Frederick Soddy "for his contributions to the chemical knowledge of radioactive substances, and his investigation of the origin and nature of isotopes."

Frederick Soddy, 1877–

The youngest son of a London merchant, Soddy was born at Eastbourne, Sussex, in 1877. There he attended Eastbourne College, going subsequently to the University College of Wales and finally to Merton College, Oxford, where he graduated with "First Class Honours in Chemistry." After two years of research at Oxford he went to MacGill University, Montreal, where he collaborated with Sir Ernest Rutherford in the researches which resulted in the establishment of the theory of atomic disintegration. Working with Sir William Ramsay at the University College of London in 1903-04, he aided in obtaining spectroscopic proof of the production of helium from radium.

Soddy then became Lecturer in Physical Chemistry and Radioactivity at the University of Glasgow, 1904–14, and later Professor of Chemistry at the University of Aberdeen. Since 1919 he has held the position of Lee's Professor of Chemistry at Oxford.

The work for which the Nobel prize was awarded was done chiefly in Glasgow with the assistance of Alexander Fleck and may be said to have begun with the elucidation of the chemistry of mesothorium 1 in 1910. This led to a systematic investigation of the chemistry of the radio-elements and resulted in the formulation of the generalization connecting the chemical character of a radio-element with that of its parent and eventually in the propounding of the theory of isotopes and in the coinage of that term.

Even so brief and incomplete an outline of Soddy's contributions to chemistry suffices to indicate an outstanding characteristic of the man—his absolute intellectual independence and originality. His early work, under the direction of others, helped to overthrow one of the most fundamental and most honored of the chemical articles of faith—the immutability of the atom. Incidentally it created a problem for textbook writers and lexicographers, in that they were faced with the necessity of redefining an element. In his later work he had the vision and the courage to insist that certain pairs of radio-elements are not only chemically *similar*, as previous investigators had reported, but chemically *identical*. In thus enunciating the theory of isotopes, he did violence to another of Dalton's dicta and made further trouble for pedagogues and concoctors of definitions.

The same characteristic is outstandingly evident in his excursions into political and economic fields in late years. Even before the war Soddy had a strong interest in political economy and entertained original and

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pronounced views upon the subject. For the past decade his writings have been chiefly in this field (unfortunately, perhaps, from the standpoint of chemistry). On his political and economic views we are not prepared to offer intelligent comment. Needless to say, they are not unreservedly accepted by the more orthodox political economists. In conservatively disposed circles, so we are informed, they are sometimes regarded as little short of shocking.

Although Soddy still discharges the duties of his chair and apparently continues to carry on a considerable amount of work in his laboratory, the following partial bibliography is no doubt indicative of the trend of his major interests: "The Interpretation of Radium," 1908; "Matter and Energy" (Home University Library), 1910; "The Chemistry of the Radio-Elements and the Periodic Law," 1914; "Science and Life," 1920; "Cartesian Economics," 1922; "Inversion of Science," 1924; "Wealth, Virtual Wealth, and Debt," 1926; "The Wrecking of a Scientific Age," 1927.

Soddy has encouraged in his pupils the independence of mind so characteristic of himself and has not, like many strong personalities, sought to turn them out in his own mold. All who have come in close contact with him express the highest respect and regard for his personality and idealism.

The JOURNAL OF CHEMICAL EDUCATION *gratefully acknowledges the courtesy of* DR. RALPH E. OESPER, *of the University of Cincinnati, for the accompanying photograph of Professor Soddy, and of* DR. F. PANETH, *of the Chemisches Institut der Universität in Königsberg,* DR. F. G. DONNAN, *of the University of London, and* DR. G. D. PARKES, *of Keble College, Oxford, for much of the material on which this biographical sketch is based.*

The Elements of Chemistry

THOMAS JEFFERSON is alleged to have expressed the opinion that a revolution now and then has a very wholesome effect upon government. Whether or not he was right we shall not attempt to argue here. We do maintain, however, that in elementary instruction in any rapidly developing science periodical revolution is not only salutary but imperative.

We use the term revolution advisedly. Instruction should keep pace with scientific progress, not so much by extension of subject matter, or even by the substitution of new subject matter for old, but by complete reorganization.

The real and significant advances in science consist in the formulation of broader and more fundamental generalizations. They are not so much

accretions to the sum total of known facts, as more illuminating and far-reaching organizations of known facts.

Since real advances simplify and clarify our outlook on the science as a whole, they are capable of simplifying and clarifying elementary instruction as a whole. In fact it is precisely in such simplifying and clarifying generalizations that we have the true *elements* of the science.

It is a truism so obvious that it should never need statement that *elementary* instruction properly deals with the *elements* of a subject. Entirely too many teachers, however, suffer the delusion that it should deal with primitive approximations and empirical facts.

It is a safe first-hand guess that anything which does not necessitate a reorganization of a considerable portion of the course is probably not worth adding to an elementary course at all. We no longer teach chemistry in terms of equivalent weights and then add a final text chapter and a lecture or two on atoms and molecules. Some of us, however, still insist on committing the analogous absurdity as regards the structure of matter.

If we cannot use the structure of matter to explain and coördinate the nature of the chemical bond, valence, the periodic table, the electromotive series, oxidation-reduction phenomena, etc., we had better resign our work into more capable hands. As a mere addendum, the structure of matter is at least as bad as useless, and probably worse. So handled, it constitutes one more rather difficult topic in an already crowded course, and it pays no dividends. As a correlating agency of extensive applicability it repays many times over the initial effort expended in introducing it at the very outset of the course.

The time has now arrived when we may well give serious consideration to the advisability of introducing other modern ideas into elementary instruction. For instance, chemistry, duplicating the primeval history of the race, is just beginning to emerge from the water and to realize that the universe is not exclusively aqueous. We are now aware that our older definitions of acids and bases and many of our generalizations concerning these types of compounds have been based upon the special case of aqueous solution. Physically, we live in a water world, but there is no reason why we should be confined to it mentally. It is quite possible, as Brönsted and others have shown, to evolve more general and more scientifically satisfactory acid-base definitions. To the modern chemist oxidation-reduction is no longer an empirical maze—it is a clear-cut, logical chemistry of the electron. Likewise acidimetry is becoming the corresponding chemistry of the proton. These alterations in viewpoint are fundamental—*elementary*— and they should take their place in elementary instruction.

As a further example, it seems to us that the time has come when we

should cease to implant in the minds of beginning students the erroneous and crippling notion that there is a great gulf fixed between organic and inorganic chemistry. The same laws operate in both. If the hydroxide of sodium is a base, the hydroxide of methyl an alcohol, and the hydroxide of chlorine an acid, we are faced, not by any dark and mysterious anomaly, but by a perfectly natural and predictable gradation of properties which can be explained, even to a high-school student. General elementary chemistry *is* become more *general* and it should become even more so.

Summer Study

THERE is an old and homely saying to the effect that in order to teach a dog tricks it is necessary to know more than the dog. There is apparently a tendency to take this saw as a literal prescription of minimum pedagogic requirements rather than as a humorous understatement of fact. The fallacy is obvious, however, if it be considered that not every one who knows how to walk on his hind legs can impart the same knowledge to a dog.

That teachers and educational administrators are not utterly oblivious to this consideration is evidenced by the annual migration of teachers to the summer schools. Not all, it is true, are bent on genuine self-improvement. Some are guilty of the same fault which they deplore in their students—a tendency to accumulate credits toward an advanced degree or toward the satisfaction of legal certification requirements with the least possible expenditure of thought and effort. Others find that a judicious selection of courses transforms the summer-school session into a moderately priced vacation amid new and pleasant surroundings and in pleasant company. A goodly proportion, however, undertake serious and significant programs of continuation education.

To such as these we venture to suggest the desirability of including some advanced courses in chemistry in their summer work. Every good teacher already knows that a letter-perfect knowledge of a standard elementary text does not furnish the background and the sense of proportion essential to really first-rate teaching. In our opinion one of the most valuable supplementary courses which the teacher of chemistry can elect is one in the history of chemical theories and laws. But, whatever the advanced course selected may be, we are willing to lay a small wager that to the alert and conscientious teacher it will open up new outlooks which will suggest improvements in the presentation of the course he teaches.

CHINESE POTTERY*

J. LYMAN SHEEAN, MONSANTO CHEMICAL WORKS, MONSANTO, ILLINOIS

Much has been written about certain phases of the Chinese pottery industry, yet little has been done to trace the influence of the various dynasties upon the fascinating industry. This paper in a brief way shows how the various dynasties contributed their share to an ever-growing field. The analyses of some of the glazes upon the ancient vases are given.

Throughout the development of the industry the fact must not be lost sight of that great sacrifices have been made to perfect a wonderful art.

. . . . . .

Early History

The question, "What were the mysterious forces present in past ages to lead the Chinese people to produce such marvelous designs and figures

POTTERY OF THE OLD HAN DYNASTY (202 B.C.–220 A.D.)

in the beautiful displays of Chinese pottery seen today in the world-famous museums?" comes naturally to a great number of those who visit these museums. Other subsequent inquiries have come as to the composition of the materials, the methods used in applying a deft touch here and there, and the reason for an extra heavy turn of the potter's wheel in shaping an

* The material in this article is essentially that which appeared in *Ceramic Industry*, **16,** No. 1 (Jan., 1931), and is published here with the kind permission of the editor, H. V. KAEPPEL.

exquisite vase or incense jar. Perhaps a little history and some of the chemical analyses of the glazes known to the Chinese centuries before the white man ever set his foot in this land of ours may help answer these and other inquiries.

The word pottery, as we use it, comes from the Latin word *potum* (a pot), and the word meant to convey the idea that any article made of clay and then fired came under that description. The origin of the formation of vessels was lost in antiquity for they seem to have been a product of no one nation or people but purely the result of necessity. The need for articles of domestic use arose when human kind emerged from savagery to barbarism. Later when communal life was instituted, the need was even greater.

A VERY EARLY POTTER'S WHEEL, MADE IN THE SHAPE OF A CART-WHEEL

The earliest vessels were shaped by hand and no metal tool was required. The potter's wheel is claimed by the Chinese as of their origin but, like that of several other nations, their claim cannot be substantiated. Hobson writes in "Chinese Pottery and Porcelain," (*1*)

> The priority of the invention undoubtedly rests with the near eastern nations. The production of any sort of clay vessel is dependent upon a sedentary mode of life, and pastoral tribes as a rule evince no inclination toward industry, for we see them using vessels of bark, wood, and metal, as preferable. As a result we find the potter's wheel only in the old world where it belongs to Egypt, the Mediterranean and Western Civilization, and China with her dependencies.

The Egyptian legends tell of various types of the potter's wheel and apparently it was used only in the stratum of the higher cultural stage since no use of it has been found among the primitive tribes. In both Egypt and China the introduction of the potter's wheel, at whatever period of ancient antiquity it was, made a sort of caste distinction for we find that a discrimination was made between the potter's wheel workers (*t'ao-jen*) and the molders (*fang-jen*).

Chu Yen in his "Treatise on Pottery" (*T'uo sho*) (*2*) tells us that the articles made by wheel were all intended for cooking with the exception of the vessel *Yu*, which was designed for measuring, while the output of

the molders, who made the ceremonial *kuei* and *tou*, was intended for sacrificial use. It may be true that the wheel-made jar was less sacred in character than the one made by hand but no evidence has been found to substantiate the belief.

The earliest Chinese wheels known were copied or modeled after a chariot wheel and the Chinese philosopher, Huai-nan-tse, who died in 122 B.C., wrote—"the wheel of the potter revolves, the wheel of the chariot turns, when the circle is completed, they repeat in revolution." In the porcelain factories of King-te-chen the potter's wheel is referred to as a "potter chariot" or "wheel chariot." It was a current notion in ancient China that the evolution of Heaven created the beings in the same manner as the potter turned his objects on the wheel. But be that as it may, the early potter and the agriculturalist of China were closely associated.

GREEN-GLAZED POTTERY VASE OF THE T'ANG DYNASTY (A.D. 618–906)

This vase is coated with a green glaze partially dissolved into silver iridescence. The opening is molded into the shape of lotus petals.

In ancient China the potter lived in close contact with the farmer and received grains in exchange for his products. It is an acknowledged fact that the farmer was in urgent need of the potter and his wares. The residence of a potter was determined by the sites of suitable clay and his dependence on clay digging excluded him from towns and cities.

The women of other countries were the early potters, but with the introduction of the wheel the industry passed into the hands of the men. The whole industry became imbued with a more active and vigorous spirit, for it overstepped the narrow boundary of purely domestic necessity and developed into an organized system of skilfully directed manufacture on a large scale. The men searched for clays and other materials in distant localities, and the birth of artistic pottery was inaugurated.

Ingredients

The earliest authentic history shows that the Chinese used for their pottery two principal ingredients, kaolin and petuntse. The first efforts of the potters were made largely of kaolin, for the vessels had no glaze. Thus the petuntse, which is responsible for the glaze, must have been added

GLAZED POTTERY FIGURE OF THE T'ANG PERIOD (A.D. 618–906)

This figure represents a female demon with wings, feet, and claws of a bird, so-called Kinnari derived with Buddhism from India.

at a later period. Kaolin (named after the city where it was first found) has been analyzed and described as a hydrated silicate of alumina arising from the decomposition of the feldspar granites, gneiss, and felsitic rocks. To the casual observer it is merely white clay—yet it is practically infusible, lends plasticity to the paste, and forms the main body of the vessel.

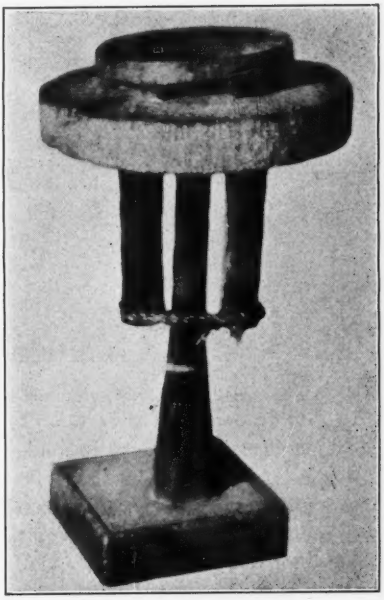
Petuntse (literally white briquette) is described as a hard feldspathic stone, fusible at high temperature. This fused form constitutes the glaze and is responsible for its transparency. The word itself refers especially to the shape in which the finely pulverized "porcelain stone," after it has been submitted to the preliminary process of pounding and decantation, is brought to the potteries. It is a white compound rock of slightly grayish tone, occurring in large fragments, covered with manganese oxide in dendrites, and having crystals of quartz embedded in the mass. It fuses completely to a white mass under the blowpipe and makes a sort of fusible glass or enamel-like substance, which property gives the ware strength, imperviousness, and translucence.

In actual practice, however, the Chinese potters used a variety of other materials, such as powdered quartz and crystallized sands. These are essential to the fabrication of porcelain, which varies materially in hardness, whiteness, and sound according to the quantity of each material used in forming the paste from which the vessel is made. A paste made from yellow brick (*huangtun*) derived from a very tough compact rock, pounded in large water mills, was used for a coarser ware, for this material was indispensable in the development of certain kinds of single glazes, especially those requiring high firing. Many kinds of the more common clays were used in making ordinary pottery,

clay rich in alumina being preferred.

When kaolin alone is used in pottery an opaque, porous, fragile ware results; on the other hand, if petuntse is used by itself, it softens in the kiln and runs together in a lump.

In typical Chinese potteries today we have a combination of three elements: (1) a porous opaque skeleton, the kaolin, (2) a transparent dense bond permeating the skeleton, and (3) a thin glossy glaze, the petuntse, on the outside, which merges imperceptibly with the body.



ANTIQUE CHINESE POTTER'S WHEEL

The glaze introduced in the later part of the Han dynasty increased the luster of the surface. It is the glaze which is intended to appeal to the spectator, for the body as a rule is invisible, and the glaze must convey an esthetic impression.

Glazes were used in Egypt in antiquity and history corroborates the fact that the introduction of glazes into China came from the west. Egyptian history shows that as early as 5500 B.C. glazing was applied to linings of rooms and it must have been about the second century B.C. when it was sent into China. However, porcelain is a truly Chinese invention and the glazes of the Chinese far surpassed those of Egypt and her contemporaries.

The first glazed vessels were burned in an underground kiln where the particles of the clayish substance solidified by artificial heat. Vessels burned underground, due to a reduction of the glaze, had that well-known iridescent and rainbow-color appearance.

In the Han annals the glossy paste for the ceramic glazes was called *lin-li*. The *Wei, lio*, written in the third century A.D., attributes ten varieties to *lin-li* (opaque glass); carnation, white, black, green, yellow, blue, purple, azure, red, and red-brown. No precious stones were used so that the *lin-li* was a man-made product. It was frequently used for architectural purposes in eaves, pillars and window bars, and glazed façades.

Later dynasties spoke of the glaze as *Yu* (jade). They prepared it from the finest petuntse, called *Yu-kuo* (jade essence), and mixed it with puri-

SPECIMENS OF POTTERY OF THE OLD SUNG DYNASTY (A.D. 960–1279)

fied lime (*lieu hui*) separately made with the addition of water "puries" of the same thickness, the fineness of the glaze depending on the quantity and quality of the two materials used.

Chinese tradition refers to the earliest employment of *lin-li* in the reign of the Emperor Wu (140–86 B.C.) of the earliest part of the Han dynasty. He sent agents over the sea to purchase it and his agents opened intercourse with Kashmir as a source of the precious material.

As early as 260 A.D., Sun Liang made a screen of clay coated with a glaze, but even earlier records show the uses of glaze in articles other than pottery—Emperor Ch'eng (32–7 B.C.) built the palace Fu'tang for Chao and had the doors glazed green. During the same period we hear of glazed wine cups and glazed bowls. The Chinese never made use of glass for practical household purposes, always preferring pottery. They served wines hot, and glass, being a much better heat conductor than pottery, was prohibited. The same fact is true in the use of tea. After the fifth century the general term *lin-li* was used to represent all glass and shiny objects.

In the third century Wau Chen gave a recipe for a glaze. He wrote:

> In order to make vessels from *lin-li*, it must be worked by means of natural ashes (Na_2CO_3). The latter has the appearance of yellow ashes which are found on the shores of the Southern Sea and are suitable also for the washing of clothes. When applied it does not require straining but is thrown into the water and becomes slippery like moss-covered stones. Without ashes material cannot be dissolved.

We find glazed tiles in the early centuries and many are preserved today, but the brick and tile of the Han and Wei periods as far as is known were unglazed. In decorating their porcelain and pottery the Chinese employed an endless variety of minerals. One of these was Mohammedan

PORCELAIN PILLOW

This pillow, in the shape of a leaf, is decorated with a design of a chrysanthemum flower and leaves in black glaze.

GLAZED POTTERY JAR

The designs of foliage are cut out in the black glaze.

DECORATED PORCELAIN JAR

This jar is coated with cream-colored glaze and covered all over with a composition of foliage of naturalistic style.

CELADON BURIAL URN

This urn is decorated with figures of twelve officials symbolizing the twelve-year cycle. The cover is surmounted by the figure of a hawk. This urn was interred in a grave for holding cereals to serve as food for the deceased person.

POTTERY AND PORCELAIN OF THE OLD SUNG PERIOD (A.D. 960–1279)

blue, the analysis of which the Chinese seem to have discovered. When they could not secure this wonderful blue, cobalt was substituted. The finest red glazes were made from copper applied on the unbaked surface with a feldspathic flux. Celadon and the deeper browns and brownish reds from iron were applied on the biscuit with a niter and lead flux. Turquoise blue was produced from copper, purple from manganese, yellow from iron containing varying amounts of antimony, greens from copper, crimson and pink from gold, coral red from iron, black from impure oxide of magnesia, and white from arsenious acid and petuntse.

Almost all the glazes change color according to the heat and the minerals used. The copper glaze, for instance, is first blood red, then dregs of wine, and as the heat is increased becomes apple green, dark emerald, and finally blue.

CELADON BOWL OF THE YUAN DYNASTY
(A.D. 1279–1368)

Contributions of Each Dynasty

The contributions of each dynasty to the Chinese pottery industry may be of interest.

The first authoritative pottery we find in the Han dynasty (206 B.C.–220 A.D.). Earlier pottery contained more or less kaolin but was not really porcelain for it was without petuntse which gave the glaze. Some of the early Han ware was unglazed. However, during this dynasty the first glazes were introduced, and from this point porcelain advanced rapidly.

There is no record that the pottery of this period was used for tribute and Bushnell in his work on "Chinese Art" (*3*) says the word *tse*, meaning pottery, came into being during this period. It is the word which means the modern word porcelain. In the Shuo-wen glossary, published 100 A.D., we find reference to *tse* but it was originally used to mean porcelaneous ware. Not until the Sui and Tang dynasties was it used to mean real porcelain.

It is interesting to note that almost all of the round jars and vases of the Han period have been shaped on the wheel, evidenced by the marks of the wheel shown by many specimens.

The Han tradition of ceramic forms died out under the Sung and Tang dynasties and in turn they gave way to more graceful and pleasing shapes.

The Wei dynasty (220–264 A.D.) is noted for its sacrificial vessels turned

GLAZED GREEN AND YELLOW ROOFING TILE

Tiles of this type are supposed to guard the house from conflagration.

TURQUOISE-BLUE GLAZED SEA-DRAGON

This dragon is represented as rising from the waves of the ocean. It was placed as an architectural ornament on the roof of an ancient temple in Shensi Province.

GLAZED POTTERY JAR

This jar is decorated with two bands of ornamental leaf designs cut out of the dark brown glaze. An inscription on it yielded the date A.D. 1393.

GLAZED GREEN, YELLOW, AND BROWN POTTERY FIGURE

This militant demon was designed to act as a guard on the roof of a house.

GREEN AND YELLOW GLAZED POTTERY VASE

This vase is decorated with coiled dragons soaring in clouds molded in high relief.

REPRESENTATIVE SPECIMENS FROM THE MING DYNASTY (A.D. 1368–1643)

at the Kuan-Chung kiln. These were all offered to the emperor. All of these ceremonial vessels were glazed but were far from the perfect glazing feats of the later dynasties.

The first Sun dynasty (420–479 A.D.) carried out a course of work closely allied with that begun in the Wei dynasty.

A change is noted in the Sui dynasty (590–617 A.D.). The early primitive stages are changing and more definite shapes and a unified method of treatment, developed to a greater phase in the Tang period, are characteristic of this period.

The Tang dynasty held sway from 618–906 A.D. This period is remarkable for its development of the ceramic and kindred arts. Life-size figures in pottery, which were considered excellent a thousand years later, were made. During this period kaolin, usually being given as pottery, formed a desirable article for tribute and taxes to the court. During the Tang period porcelain (*4*) came into vogue as a special class of ceramic ware, and a division of the nomenclature took place; *lin-li* was the term applied to common pottery while *Yu* represented the porcelain.

PORCELAIN JAR IN BLUE AND WHITE OF THE K'ANG-HSI DYNASTY (A.D. 1662–1723)

This bowl was used for keeping gold-fish, first domesticated by the Chinese. It is decorated with a fine composition of lotuses in a pond.

The following localities produced porcelain under the Tang dynasty. In Hung Chou (in Chi-li) were produced porcelain vessels accepted as tax tribute. It is a remarkable fact that only porcelain from this one district was accepted for tribute, no doubt due to the excellent quality of the kaolin in this region. Other localities were Ting-Chow (in Chi-li) Yu Chow, Yue Chow, Joa Chow (in Ki-ang-si), and Hohnan-fu.

In his "Chan of Chronicles" published in 851 A.D. Soleyman (*5*), the Arabic merchant, testifies as follows:

> There is in China a very fine clay from which are made vases having the transparency of glass bottles. Water in these vases is visible through them and yet they are made of clay, pure white porcelain oval cup, finished in relief and surrounded by wave designs and birds on the wing.

The Sung dynasty held sway from 960–1280 A.D., but by the 16th century it had become legendary in so far as its characteristics were outstanding. We find many exquisite designs in this period. During this

PAIR OF DARK OLIVE GREEN BEAKER VASES, HAWTHORNE DECORATIONS, OF THE K'ANG-HSI DYNASTY (A.D. 1662–1723)

MIRROR BLACK BEAKER, RED AND WHITE HAWTHORNE DECORATIONS, OF THE K'ANG-HSI DYNASTY (A.D. 1662–1723)

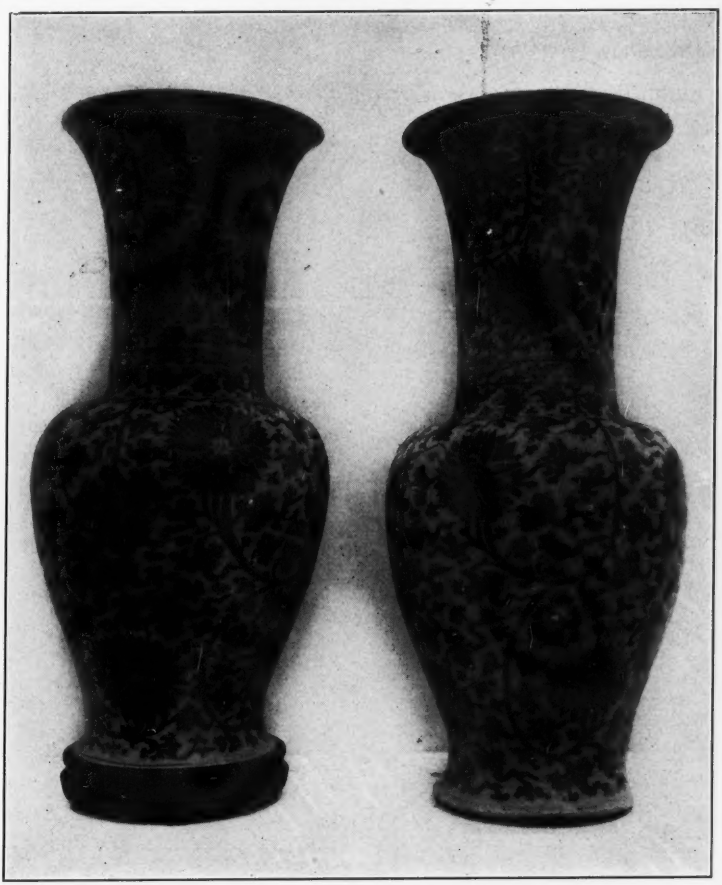
period we find an introduction of porcelain stoneware and of various colored layers of clay in the foundation base. This effect was the prototype of the agateware of Wedgwood. We are just now beginning to imitate the crackled ware and wonderful colors which were produced during this period by a reducing flame.

The beautiful celadons come from the Yuan dynasty (1280–1368 A.D.). They are forerunners of the true porcelain, which was probably produced early in the Ming dynasty.

The Ming dynasty (1368–1644) stands out as the one in which the radical change from porcelaneous wares to the real porcelain was begun. This was carried out through later dynasties until it culminated in the K'ang-hsi era.

The Chinese are indefatiable workers and acknowledged past masters of the ceramic art, but they delight in reproducing their own past triumphs. They have been so clever and skilful in these reproductions that only an expert can detect the reproduction.

The T'sing dynasty (1624–1795) flourished under four emperors. Of the Shun-Chih period (1624–1662) little is known of the pottery and porcelain wares. However, the greatest ceramic period is found under the next three



BLUE AND WHITE BEAKERS OF THE K'ANG-HSI DYNASTY (A.D. 1662–1723)

emperors—K'ang-hsi (1662–1723), Yung-Cheng (1723–1736), and Ch'ien-lung (1736–1795).

The greatest progress and the culmination of the art was reached during the K'ang-hsi period. At this time the imperial potteries at Chung-te-Chen had 3000 furnaces and gave employment to nearly a million people. From these furnaces came the purest porcelain, the finest in both shapes and finish of any pottery ever produced in any country by any age. The Peachbloom and Hawthorne designs come from this period. The blue and white beakers were made in the latter part of it. The green and black vases were produced during this reign, probably

BLACK VASE, WITH PAN-KU DECORATIONS IN RELIEF, OF THE K'ANG-HSI DYNASTY (A.D. 1662–1723)

one of the finest being the Pan-ku (hundred antiquities) in which all the figures were placed in relief on a shining black vase.

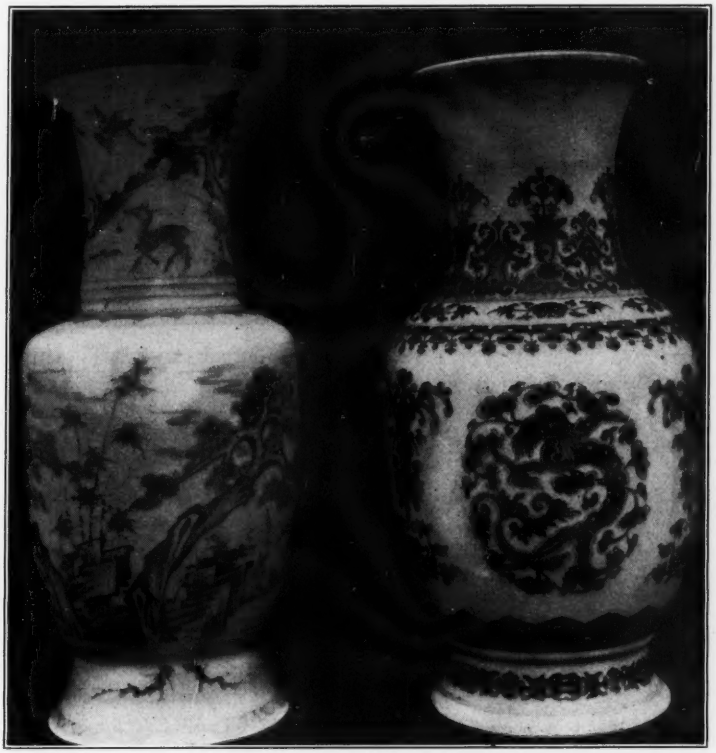
The Ch'ien-lung period was famous for its Hawthorne ginger jars.

Since the 7th century the town of Chung-te-Chen has been the center of the industry, records of kilns in this district being a rather interesting sidelight as to the real origin of transparent pottery. It seems that the Chinese had great love and reverence for jadestone and it was in the attempt to obtain a substance with the qualifications of this hard, semi-translucent, greenish yellow mineral (nephrite) that kaolin was used for body or mass and later this was combined with other siliceous material. Celadon was the outcome from which wonderful bowls, vases, and the like were produced.

Chemical Analyses

H. W. Nichols, assistant curator of geology, in the Field Museum of Natural History, has furnished us with a chemical analysis of fragments of the early Han porcelaneous pottery. He describes the body of the ware as being from three-sixteenths to one-quarter of an inch thick and consisting of a gray vitrified porous substance. The outside of the body was coated with a thin red opaque slip; on the inside was a white engobe and a thick transparent greenish yellow glaze.

The glaze was scraped off and the body gave the following analysis:



BLUE AND WHITE SHORT BEAKERS OF THE K'ANG-HSI DYNASTY (A.D. 1662–1723)

Analysis of the Body

	Han	*Modern Japanese*
SiO_2	71.61%	71.31%
Al_2O_3	18.67%	19.74%
FeO	3.57%	0.73%
CaO	0.59%	0.17%
MgO	0.33%	2.04%
Na_2O	4.43%	0.10%
K_2O	1.37%	4.04%
	100.57%	98.13%

The analysis shows that the body had all the chemical characteristics of a true porcelain and its comparison with the analysis of modern Japanese pottery shows it to be of practically the same composition.

Nearly all the analyses of Chinese porcelain indicate a great variation of composition and this is to be expected. The main distinction, aside from the silica-alumina ratio, is the appearance of the material in the body structure. The ancient Chinese pottery appears to be a sort of solidified froth composed of pores enclosed by thin walls of a translucent porcelain-like substance. The pores are elongated; hence a well-defined laminated structure is found. Although the early pottery does not look at all like porcelain, the only real point of difference, as far as the body is concerned, is the porosity of the ware, due to the use of too coarsely ground material.

The real charm of Chinese pottery is in the glaze, which on the outside of a vessel is usually very thin, yet as a rule uniformly distributed.

The white base composed of a white clay tends to give a light-colored background for the transparent glaze. This enhances its brilliancy and provides an impervious support for the glaze, which otherwise probably would have been absorbed into the pores of the body during the firing. No doubt the outer coat was applied, in most cases, by dipping. However, there is evidence that it was applied, in some cases, by spraying.

All the early glazes were an alkali-lime-alumina silicate combination and we are indebted to Mr. Nichols again for an analysis of the greenish yellow glaze.

Analysis of the Glaze

SiO_2	54.17%
Al_2O_3	14.16%
FeO	4.38%
CaO	19.05%
MgO	2.04%
Na_2O, K_2O	5.49%
	99.29%

Evidence shows that the glaze has been prepared by mixing the material of the body with pulverized limestone—probably made by adding one part of limestone or the lime burned from it to two parts of clay from which the body was prepared.

Modern Chinese glazes are made by mixing lime with one or two ingredients which make the body; a condition which seems to be peculiar only to Chinese pottery.

It is quite probable that the Chinese glaze was originally made by mixing three ingredients—a lead compound, a copper compound, and a form of silica. This fuses at a very low temperature, has a high refractive index, a high specific gravity, and a high coefficient of expansion.

The chemical facts the Chinese have employed, however, may not interest the average layman—for he sees only the beauty in the article itself.

GINGER JARS, HAWTHORNE DECORATIONS, OF THE K'ANG-HSI DYNASTY (A.D. 1662–1723) AND THE CH'IEN-LUNG DYNASTY (A.D. 1736–1795)

Museum Collections

There are several excellent collections of Chinese pottery in the American Art galleries, one of the most complete being the T. B. Walker Art Gallery in Minneapolis. Should you ever be privileged to visit the Chinese section in this or any other gallery, look for the beauty of design, the radiance of color, the perfect symmetry, but through them catch a glimpse of the millions of men who have toiled, generation after generation, down through the ages to perfect the truly marvelous designs before you. As Hazlett has so well said, "No man can thoroughly master more than one art or science." The Chinese have mastered the art of making pottery and they alone have reached heights known to no other nation.

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(*2*) CHU YEN, "Treatise on Pottery," Chap. 2.
(*3*) BUSHNELL, "Chinese Art," pp. 93–8.
(*4*) LAUFER, "The Beginnings of Porcelain in China," Field Museum of Natural History, Chicago, Ill., **1917**, pp. 86–94.
(*5*) SOLEYMAN, "Chan of Chronicles," written 851 A.D.

Research at Antioch College. Research and teaching are opposed only as business opposes family life, each competing for limited time. Life should include both. Without the research spirit, teaching is but indoctrination. Lacking a spirit of inquiry, one cannot transmit it. Conversely, research without teaching fails to transmit its ardor, insight, and skill. The research man who does not teach has no spiritual children. Research should associate with education to infect students with its spirit and, by inspiring student minds, to replenish its ranks. The research spirit should be caught during undergraduate years.

Research spirit and methods are essential equipment for educated men. The writer has worked in engineering, in devising legal codes, and in education. Everywhere effort at mastery leads to new territory and demands research. He who lacks its spirit and methods is not educated. Antioch encourages research as essential to symmetrical education.

This attitude toward education is menaced from two directions. In some quarters there is a tendency to decry research. Because research men are often chosen to do teaching for which they are not qualified, it is assumed that teaching and research are somehow antagonistic. It is assumed also that a transmitter of information may be a good teacher, even though the fire of critical inquiry has never burned in him. On the other hand, the director of a newly established research foundation openly rejoices that there are no undergraduates about. Unless that institution secures young men and women who as undergraduates have been fired by the spirit of intellectual exploration, it will become inconsequential.

By the establishment of semi-independent research projects, Antioch inspires undergraduates with interest in original inquiry, supplies new blood to research personnel, gives regular teachers as much part as they can well take in research, and gives research men as much teaching as they may desire.—*Antioch Notes*

THE REFINING OF MESOTHORIUM

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Mesothorium, an isotope of radium, is of fundamental interest for its radioactive properties. Its limited occurrence in nature, and its extraction and recovery from monazite sand are first discussed; then the process of refining the precious element is described in some detail. Incident to the handling of highly active radioactive substances, certain hazards to the workers have been studied. The precautions taken to protect workers engaged in refining operations against the radiations have been extended so as to render the occupation safe. Since, weight for weight, mesothorium is about two hundred fifty times as active as radium, the actual quantity of mesothorium in commercial samples is extremely small. The methods used in measuring the mesothorium in concentrates and keeping track of its distribution in separations from other elements constitute another section of this report.

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In 1920 the University of Missouri equipped an experimental laboratory for the study of processes of extraction and recovery of radium from typical American carnotite ores. With the equipment installed, batches of ore or concentrates as high as 100 pounds could be treated. The experimental work was eventually extended to include the refining of radium. About 200 mg. of radium as high-grade radium bromide was finally produced.

The refining of mesothorium was begun here in 1918, and has been continued ever since, but the initial steps in the commercial production of mesothorium—its extraction and recovery from monazite sand—have not been attempted. The laboratory for refining mesothorium has now been in operation for twelve years. More than 3000 mg. of high-grade mesothorium, expressed as radium equivalent, have been produced mainly by students working under the direction of Dr. G. F. Breckenridge and the writer. In connection with this technical work several theoretical problems have been studied on the concentration of mesothorium by fractional crystallization. At the present time further studies are in progress on the health hazards involved in the handling of radioactive substances. By-products, such as radiothorium, thorium X, and thorium B, have been extracted from mesothorium residues and these have served several scientific workers in physics and biology in other universities.

In preparing this paper it was the writer's intention to restrict it to a description of the steps in the refining of mesothorium after the concentrate has been converted into water-soluble form, but the introduction has expanded until the whole has ended in a general paper on mesothorium. We shall consider first the radioactive and chemical properties of mesothorium.

Occurrence and Properties

Mesothorium is a very rare element. It is a radioactive element. As its name indicates it is a member of the thorium series of radio-elements.

In nature it occurs in thorium-bearing minerals only. Its chief source today is monazite sand found chiefly in India and Brazil. Mesothorium is the immediate offspring of thorium. Like other radioactive elements it undergoes transformation or disintegration, thus producing new elements. This change takes place spontaneously regardless of the other elements with which it may happen to be in combination. In other words, the decomposition is an atomic property. Its rate of transformation remains uninfluenced by the conditions which determine the speed of chemical reactions, such as pressure, temperature, concentration, and other elements in combination with it. This changing nature of the element gives it a transient existence.

The rate at which mesothorium decays is definitely known. With the lapse of 6.7 years, a given specimen of mesothorium, separated, of course, from its parent, thorium, decays to half value. Let another 6.7 years pass by, and then only one-fourth of the original amount will remain unchanged. An added third interval of 6.7 years will see the amount in hand again reduced by one-half; that is, only one-eighth will remain unchanged; and so the progressions go on, the amount of mesothorium remaining unchanged, decreasing in geometrical progression with arithmetical progression of time. Its rate of change can be stated more definitely by saying that mesothorium decays continuously and spontaneously at a perfectly fixed rate or constant rate, namely 10.3 per cent per year. Sometimes this relation is stated in this way: mesothorium like other radioactive elements decays according to a simple exponential law characteristic of first-order chemical reactions. Put in mathematical form the statement is

$$N_t = N_0 e^{-\lambda t}$$

or

$$\frac{N_t}{N_0} = e^{-\lambda t}$$

where N_0 represents the number of atoms, or quantity of mesothorium originally present in the given sample, N_t, the number of atoms remaining unchanged after a time, t; e is the base of the natural system of logarithms, 2.71828, and λ is a constant, called the transformation or radioactive constant, which characterizes the change which takes place. When time is expressed in years then the transformation constant, λ, has the value 0.103 or 10.3 per cent. If, in a given specimen of mesothorium, the original quantity be kept constant then 10.3 per cent of the atoms present decay per year. By means of this simple exponential formula we can readily compute the fraction of mesothorium which remains at any time after its separation from its parent source, thorium. Contrasted with its isotope, radium, whose half-life period is 1600 years, we see that mesothorium decays nearly 250 times faster than radium. The transient existence of

the element is thus again emphasized. However, compared with some other radio-elements its life period is relatively long.

In thorium-bearing minerals, the only natural source of mesothorium, the quantity of mesothorium is fairly definite. It is directly proportional to the thorium content of the mineral. For example, a sample of monazite containing 6 per cent thoria (thorium oxide, ThO_2) contains approximately 3 mg. of mesothorium per ton of ore, 1 mg. of mesothorium being the quantity that has the same gamma-ray activity as 1 mg. of radium (element). As the uranium : radium ratio is very nearly 3.0×10^6, it is easily deduced that it takes six times as much thorium in a mineral per mg. of mesothorium as uranium per mg. of radium.

It should be borne in mind, however, that the quantities of mesothorium expressed in the conventional way, in terms of radium equivalent by the gamma-ray activity, does not give the actual amount of mesothorium by weight. The actual weight of mesothorium present in a sample, which is weight for weight just as active as a sample of pure radium, runs only about one-fourth of one per cent of mesothorium (element), practically the entire mass being barium and radium compounds. Likewise specimens of mesothorium free from radium, prepared chemically from mantle ash, are barium compounds, the actual quantity of mesothorium constituting a mere trace. Notwithstanding the minute mass of mesothorium in such preparations, its relatively rapid rate of decay imparts to them a gamma-ray activity comparable to that of radium.

We have seen that mesothorium is not only a rare element but that it is a transient element. How is it then that the quantity of mesothorium in a thorium-bearing mineral remains constant, or fixed, in amount over long periods of time? This question finds a complete answer in the Rutherford-Soddy theory of radioactivity by atomic disintegration. In natural thorium-bearing minerals we have a state of radioactive equilibrium. In minerals both thorium and mesothorium are continually decaying, but the percentage, or fraction, of the atoms of thorium changing into mesothorium per year is very small, thorium decaying extremely slowly; about 17 billion years must pass by for one-half of a given sample of thorium to be transformed, as against 6.7 years for the half-life period of mesothorium. So, for all practical purposes, we may consider the quantity of thorium in a given mineral as constant. The mesothorium content of the mineral also remains constant, for as fast as atoms of mesothorium undergo transformation, an equal number of fresh atoms of mesothorium are formed by atoms of thorium "begetting" mesothorium. Atoms of mesothorium are being supplied continuously from the huge reservoir of thorium atoms in the mineral as fast as the atoms of mesothorium run out. This situation is called radioactive equilibrium. Please note that the source of the equilibrium stock of mesothorium atoms is based upon the prac-

tically constant head of thorium atoms in the parent reservoir. The number of atoms of mesothorium decaying, say per year, in a sample of monazite sand is given by $\lambda_1 N_1$, where N_1 is the total number present and λ_1 is the transformation constant, the fraction 0.103; but the atoms of mesothorium changing is being replenished by the changing of the same number of atoms of thorium into mesothorium. Let N denote the number of atoms of the parent thorium in the sample of monazite, and λ the transformation constant $4 \times 10^{-11}\ yr^{-1}$, then λN gives the number of atoms of thorium decaying per year, which is equal to the number of atoms of mesothorium which undergo change per year. That is, the radioactive equilibrium between thorium and mesothorium is given by the simple relation

$$\lambda N = \lambda_1 N_1$$

The thorium content of a mineral being known by chemical analysis, it is not a difficult matter by starting with the above relation to compute the quantity of mesothorium in equilibrium with it.

Among the thirty-odd radioactive elements, mesothorium probably ranks next to radium in practical importance. Like radium, the successive transformation products of mesothorium emit the three types of radioaction that are characteristic of radioactive substances, and that are known as alpha (α), beta (β), and gamma (γ) rays. As already stated, mesothorium decays nearly 250 times faster than radium, and hence in the pure state its activity, weight for weight, would greatly exceed radium. Mesothorium however has never been prepared in the pure state, and hence its atomic weight, 228, is assigned to it by subtracting 4 from the atomic weight of thorium, the loss of four units representing the expulsion of a helium nucleus from the disintegrating parent thorium atom.

Although itself rayless, or emitting only very soft beta rays, its first transformation product, mesothorium 2, which is rapidly formed in a freshly prepared specimen of mesothorium, gives off a powerful beta and gamma radiation. Mesothorium 2 attains equilibrium with its parent mesothorium 1 in freshly prepared material after an interval of three days. Mesothorium then which is a few days old contains both mesothorium 1 and mesothorium 2; but in addition all new preparations of mesothorium from thorium-bearing minerals contain also radium and thorium X. The source of the radium in commercial samples of mesothorium is the small amount of uranium which is usually associated with thorium in the monazite sand. Radium and mesothorium have identical chemical properties. They appear in the same place in the periodic table, and were called by Soddy isotopes. Isotopes have the same atomic number, that of radium and mesothorium being 88. But element 88 has another isotope, thorium X, a lineal descendant of mesothorium. Hence, new preparations of mesothorium always contain, besides radium, thorium X. For this reason the

beta- and gamma-ray activities of freshly prepared mesothorium are variable during the first month. By the end of this time, radium emanation and its short-lived products—Ra-A, Ra-B, Ra-C—have attained equilibrium, when specimens are kept in sealed tubes. During this first month of separate existence of mesothorium from its parent thorium, the thorium X and its radioactive products decay almost completely. Again, during the first month after separation, specimens of mesothorium "grow" a small quantity of another member of the thorium series, radiothorium, which determines the amount of another gamma-ray producer, thorium C″, the gamma rays from thorium C″, formerly called Th-D, being the most penetrating known. As time goes on the steady growth of radiothorium (and thorium C″) in the sample of mesothorium favors an increase in the gamma-ray activity from this source. At the same time, however, the mesothorium 1 is decaying and with it mesothorium 2, also a source of gamma rays. The increase in gamma-ray activity of thorium C″ from radiothorium more than compensates for the decay of mesothorium. Consequently, the total gamma-ray activity of a specimen of mesothorium will change with aging. For nearly five years after separation the gamma-ray activity of specimens of mesothorium gradually increases when measured against a radium standard.

The maximum gamma-ray activity is attained about five years after separation from the monazite, and its value becomes fully twice that of the mesothorium present at that time. A gradual decline in gamma-ray activity then takes place, but after a lapse of ten years the gamma-ray activity still slightly exceeds that of the initial value. This apparently anomalous behavior of mesothorium preparations in maintaining a higher gamma-ray activity than an equivalent quantity of radium, which remains practically constant over long periods, finds a complete explanation in the more extended theory of successive radioactive changes. A full discussion of such cases may be found in works on radioactivity, for example, Rutherford's book, "Radioactive Substances and Their Radiations."

A glance at the accompanying diagram showing the genetic relations of the successive members of the thorium series reveals at once the existence of five elements following mesothorium that emit alpha rays. The alpha radiation from freshly prepared radium attains a maximum within a month after sealing, whereas that of mesothorium increases comparatively slowly, and reaches its high point during the fifth year after separation. Mesothorium preparations therefore must be "aged" before their full alpha-ray effect is realized when mesothorium is used in making radioactive luminous compounds. Upon aging, its alpha rays for some years exceed in number the alpha rays emitted by the equivalent amount of radium. We have thus seen that mesothorium preparations emit the three types of rays so characteristic of radium. Mesothorium may thus

serve perfectly as a substitute for radium both in radioactive luminous compounds and for certain therapeutic purposes. Its logical use, it seems to me, lies in the luminous materials business. Strangely enough, in the United States practically no mesothorium is being used in the luminous paint applied to watch dials. Radium is used instead. That mesothorium serves fully as well as radium in luminous materials has long been established and recognized. Moreover, mesothorium is cheaper than radium, costing only about two-thirds as much as radium. Although mesothorium decays nearly 250 times faster than radium, over a period of fifteen years, the brightness of luminous materials activated with mesothorium are in no way inferior to those made luminous by radium. The base of the luminous paint, a specially prepared phosphorescent zinc-sulfide, loses most of its response to alpha radiations by incessant bombardment. Then why not substitute mesothorium for radium, and thus conserve the equivalent supply of radium for use in hospitals?

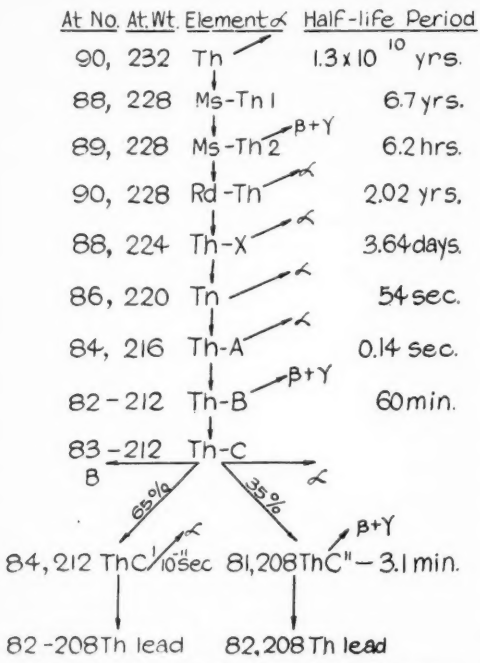
At No. At. Wt. Element α Half-life Period
90, 232 Th 1.3 x 10 10 yrs.
88, 228 Ms-Th 1 6.7 yrs.
89, 228 Ms-Th 2 β+γ 6.2 hrs.
90, 228 Rd-Th α 2.02 yrs.
88, 224 Th-X α 3.64 days.
86, 220 Tn α 54 sec.
84, 216 Th-A α 0.14 sec.
82-212 Th-B β+γ 60 min.
83-212 Th-C
β
65%
35%
α
84, 212 ThC' 10-11 sec
β+γ
81, 208 ThC" — 3.1 min.
82-208 Th lead
82, 208 Th lead

FIGURE 1.—THORIUM SERIES OF RADIO-ELEMENTS

The members of the thorium series of radio-elements are listed in Figure 1, which makes their genetic relations clear, and shows the type of radiation emitted by each member. The atomic numbers and atomic weights have been placed to the left of the elements, while to the right the half-life periods are recorded.

Thorium C, like its corresponding member in the radium and actinium series, has two modes of transformation. It is seen that one branch, claiming 65 per cent of the atoms changing, emits beta rays, and produces Th-C[1] which changes almost instantly with the expulsion of an alpha particle into the end member of this branch, thorium lead, atomic weight 208, and isotopic with the end member of the radium series, radium lead,

atomic weight 206. The minor branch, claiming 35 per cent of the atoms, represents an alpha-ray change producing thorium C″, frequently still called thorium D, which emits both beta and gamma rays, and is responsible for the entire gamma radiation emitted from the products of thorium C. The gamma rays from thorium C″ are more penetrating than those from radium C or mesothorium 2. It is important to note that McCoy and Cartledge found that thorium C″ furnish 1.8 times as much gamma activity as the mesothorium 2 with the same amount of thorium. As only about 35 per cent of the thorium disintegrates into thorium D, this means that thorium D contributes 5.14 times as much gamma activity as mesothorium 2. These investigators therefore conclude that "this result shows conclusively that an atom-for-atom relation does not hold for gamma radiation." It is far more probable, they say, that the intensity of the gamma radiation is related closely to the speed of the accompanying beta rays.

Since mesothorium is identical with radium chemically, and both elements are closely analogous to barium, mesothorium cannot be separated from radium. Therefore, radium extracted from uranium minerals also containing thorium will always contain mesothorium, and conversely mesothorium separated from monazite sand usually owes from 10 to 20 per cent of its activity to the radium in the monazite. In a mineral containing an equal proportion of uranium and thorium, the gamma radiation contributed by the radium is nearly six times as strong as that due to mesothorium alone, and nearly two and one-half times the total gamma radiation from mesothorium and thorium C″ when measured through one centimeter of lead.

In standardizing commercial specimens of mesothorium the gamma-ray comparisons are made against radium, containing the equilibrium amounts of its short-lived products. The gamma-ray comparisons are made thirty to forty days after separating and sealing the finished specimens, the ionization chamber of the electroscope being screened by 1 cm. of lead. At this time mesothorium 2 is present in equilibrium amounts, but only a small fraction, less than 5 per cent, of the equilibrium or normal amount of radiothorium has accumulated during this interval. The measured gamma-ray value thus represents the combined effect of the mesothorium, the radium and the trace of thorium C″ in the specimen. As time goes on, the gamma radiation from thorium C″ increases more rapidly than the decline of mesothorium itself which results in an increase in gamma-ray activity over a four-year period. The maximum value thus attained has been estimated to be 1.6 times the initial rating by comparison of the gamma-ray effect.

The number of alpha particles emitted by 1 mg. of mesothorium is a variable quantity depending upon the age of the specimen.

Referring to the thorium series of radio-elements it appears that the alpha

radiation is governed by the amount of radiothorium which accumulates as the years pass by. It is generally conceded that a milligram of mesothorium two to three years old, emits fully as many alpha particles as a milligram of radium, although when first separated the small alpha radiation is contributed largely by the little radium present.

The growth of radiothorium in mesothorium preparations may be computed at any time by the relation

$$R = \frac{M\lambda_1}{\lambda_2 - \lambda_1}(e^{-\lambda_1 t} - e^{-\lambda_2 t})$$

where t is the age of the specimen (the time which has elapsed since separation from its parent thorium), M is the initial radium equivalent, λ_1 and λ_2 are the transformation constants of mesothorium (0.103) and radiothorium (0.364), respectively. The alpha-ray activity of specimens of mesothorium reaches a maximum during the fifth year after separation, when $t = 4.83$ years.

Extraction from Monazite Sand

Thorium occurs with cerium and other rare earths as phosphates in monazite. Mesothorium, however, is a member of the alkaline earth group of elements. Its nearest analog is barium. Ever since the perfection of the thoria mantle by Auer von Welsbach, monazite sand has been the main source of the thoria required in the mantle industry. The treatment of the sand had for its objective the extraction of the thoria. Only quite recently have the cerium and other rare earths assumed commercial significance. When the recovery of the minute trace of mesothorium in monazite was begun, it represented the conservation of a by-product, and that is still the situation today.

For several years after Hahn's discovery of mesothorium in 1907, its method of extraction was kept a technical secret. But when Soddy and Marckwald, a few years later, independently established the chemical identity of mesothorium and radium the trade secret vanished. Evidently the well-known methods of extracting radium thereby became the standard procedures for the production of mesothorium. Though the chemistry of mesothorium and the methods of refining were thus clearly defined, its production involved many problems for investigation. The question of prime importance is, of course, the percentage recovery of mesothorium in the plant processes employed in the extraction of thorium, and what modifications of the plant processes will increase the yields of mesothorium. It is evident of course that the very minute trace of mesothorium in the monazite will be dissolved and pass into the various discarded wash liquors and thus be lost. To avoid this loss, the same protective means were used as the recovery of radium demands; namely, the addition of barium

compounds at the proper stage in the process of extraction. The quantity of barium added to prevent the loss of mesothorium runs about one-half of one per cent of the weight of the ore. In some experimental runs made in the Welsbach plant some years ago it was found that the presence of one-fifth of one per cent of the weight of the ore resulted in as good a recovery of mesothorium as the addition of one per cent of crystallized barium chloride. The barium is added before decomposing the monazite by digesting it with hot concentrated sulfuric acid. After cooking with sulfuric acid the product is dumped into water and diluted further with vigorous stirring. In this operation the mesothorium precipitates quantitatively with barium as sulfate. Thorium and other rare earths also precipitate as phosphates or pyrophosphates. The barium sulfate bearing the mesothorium and radium thus accompanies the thorium and other rare earths as these precipitates are carried off from the unattacked impurities in the sand remaining as a sediment in the tank. By this method of treatment from 5 to 10 per cent of the mesothorium usually remains with the coarse, unattacked mineral in the monazite sand.

The liquor carrying in suspension the radioactive sulfates and phosphates of thorium and other rare earths is next given a treatment for the separation of the greater part of the associated rare earths, leaving the thorium to settle out as phosphate. The barium-mesothorium-radium sulfates accompanying the thorium phosphate from this point on until the hydroxide of thorium is finally converted into sulfate. The insoluble residue, a black pasty mass, carries the radioactive barium sulfate. This crude concentrate bearing the mesothorium is then converted into acid-soluble carbonate by digestion with a hot concentrated solution of soda ash. The impure barium carbonate thus obtained, known in the trade as "mesothorium mud," constitutes the source material for the first stage in the concentration and refining of mesothorium. In plant operations, the percentage recovery of mesothorium in the carbonate mud runs from 60 to 80 per cent of that present in the monazite, when care is exercised in avoiding mechanical losses of the finely divided barium sulfate in the copious wash liquors used in the recovery of thorium. The concentration of mesothorium in the dry crude concentrate runs from 0.5 to 1 mg. per kilo.

Concentration by Fractional Crystallization

Mesothorium and radium having identical chemical properties, the concentration of mesothorium by fractional crystallization of the barium solutions is in practically all respects the same process as that of concentrating radium. In chloride or bromide solutions the mesothorium continues to be enriched in the crystal fractions, and impoverished in the successive mother liquors. The chlorides and bromides of mesothorium and radium are less soluble than the barium salts, a relation that favors an

enrichment of mesothorium and radium in the crystals. On the other hand, the solubility of the hydroxides of the alkaline earth metals increases with increase of atomic weight and in fractional separation of the hydroxides McCoy has shown that the mesothorium enriches in the solution.

In commercial refining about five fractionations are made in a chloride system, the stock barium solution being obtained by treating the carbonate mesothorium mud with hydrochloric acid. When the concentration of mesothorium and radium in the crystals of the head dish reaches twenty to forty mg. per kilo, then it is advisable to convert the chlorides into bromides, as the enrichment factor for bromides is higher than that for chlorides. The number of fractionations that must be made in stepping up to the desired end concentration in the finished product is thereby materially reduced. The enrichment factor in the fractionation of chlorides runs about 1.6 when 50 per cent of the salt in solution is separated out. In bromide systems the enrichment factor runs as high as 2.0 and 2.2 when about 40 per cent of the crystals are separated. The enrichment factor also designated variously by other authors—"crystallization factor," "concentration factor," "fractionation factor" as here used, represents the concentration of mesothorium in the crystals separated to the concentration in the crystals used in preparing the solution—concentrations being expressed as mg. of mesothorium (in terms of radium equivalent) per g. or kg. of anhydrous crystals. The enrichment is considered more favorable in acid than in nearly neutral solutions, but this practice appears to be largely a myth, for it has been shown in our refining laboratory here at the University of Missouri that the controlling factor in enrichment is primarily the fraction of crystals which separate in each step.

To make the matter of concentrating mesothorium by fractional crystallization concrete, let us start with a stock solution of bromide liquor made from crystals containing 80 mg. of mesothorium per kilo. The solution is concentrated by boiling off water to the point where, upon cooling, 42 per cent of the crystals in solution crystallize out. The mother liquor is next transferred to another dish, and the well-drained crystals are redissolved in a minimum volume of hot water. The solutions in both dishes are then concentrated by boiling. Upon cooling let us assume that again 42 per cent of the salt crystallizes out in each dish. The separation of mother liquor crystals is then made in each dish; the mother liquor from the + 1 dish (see Figure 2) is then combined with the crystals in dish −1 of series 2, and this solution then becomes dish 0 in series 3. The crystals remaining in dish +1 of series 2 are dissolved and become dish +1 in series 3, while the mother liquor remaining in dish −1 in series 2, now becomes dish −1 in series 3. In the third series of fractionations three crops of crystals are obtained. It is apparent that a continuation of the fractiona-

tions will distribute the original material over more and more dishes. Naturally the fractionations in the successive series are thus carried out in smaller dishes. It is hoped that Figure 2 will give a clear idea of the plan of the crystallizing system. Each circle represents a dish, and the successive series of fractionations are numbered on the right. Besides the number of the dish in the center, each circle in the diagram contains the weight in grams of salt in the dish and the concentration of mesothorium. The amount of mesothorium in each dish stands to the right of the circle on the plus side and to the left on the minus side. The crystals pass up on the plus side in successive

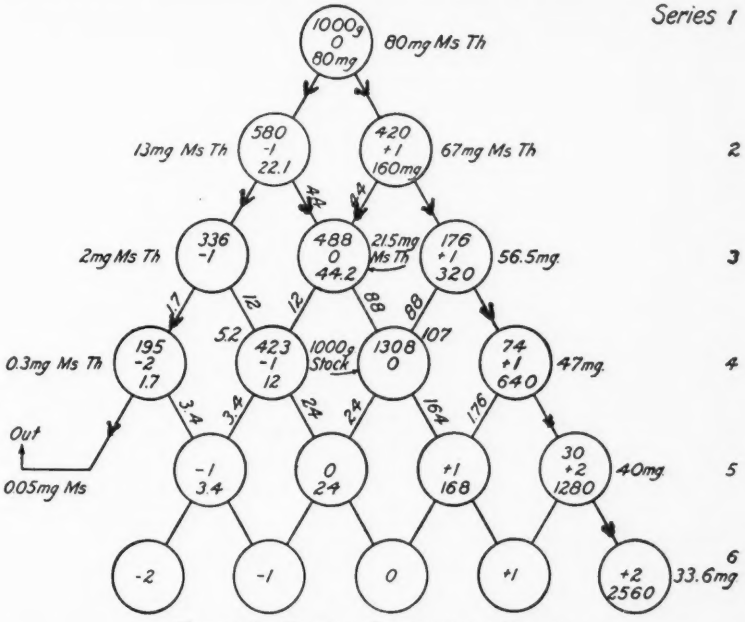

FIGURE 2.—BROMIDE CRYSTALLIZING SYSTEM

series whereas the liquors pass toward the minus side, and it should be noted that crystals and liquors of the same concentration always meet, and will continue to do so unless somewhat disturbed by the introduction of fresh stock liquor as shown in zero dish of series 4 where liquor from stock crystals containing 80 mg. per kilo is combined with liquors and crystals each of concentration 88 mg. per kilo.

As long as the fraction of salt crystallized out in each dish is held constant, liquors and crystals of the same concentration will always meet when the simple plan of transfer in Figure 2 is followed. In practice this ideal is of course not attained.

This diagram of the partial crystallizing system furthermore shows that in the first fractionation, as 42 per cent of the salt crystallizes out, 420 g. of crystals will be obtained whose concentration is 160 mg. of mesothorium per kilo, making the total mesothorium in the crystals 67.2 mg., or 84 per cent of the mesothorium passes up to dish +1 of series 2, while 16 per cent of 80 or 12.8 mg. of mesothorium passes down to dish −1 of series 2, which contains 580 g. of the original salt. Hence the concentration of mesothorium in the salt remaining in solution is $12.8 \div 0.580 = 22.1$ mg. per kilo of bromide crystals. As the crystals separated in the first fractionation contain 160 mg. mesothorium per kilo, the ratio $\frac{160}{22.1} = 7.24$ shows how many times more concentrated the mesothorium is in the crystals separated than in the salt of the mother liquor. Another relation is of interest. Since a single fractionation gives 84 per cent of the mesothorium in the crystals and only 16 per cent remains in the mother liquor, it is seen that in the parting 5.25 times as much mesothorium appears in the crystals as remains in the mother liquors. This example gives the fundamental constants to be applied in each crystallization throughout the entire fractionation process.

The underlying idea of this scheme of fractional crystallization is to have the steps in the concentration from dish to dish in each series as great as possible, 7.24 for the example cited. The number of dishes in any series is thereby reduced to a minimum. In operating any crystallizing system, care must be exercised in adding stock liquor to the dish where it will be combined with crystals (or mother liquor) of approximately the same concentration.

After 25 to 30 series of fractionations the small crop of crystals in the head dish will usually attain a concentration of mesothorium equal in gamma-ray activity to a sample of pure radium bromide. After being thoroughly dried at 300°C. for at least an hour the head crystals are transferred to a small weighed glass tube, and the weight of the anhydrous salt is determined, special care being exercised to exclude moisture by heating the tube again just before it is finally sealed. After the finished specimen has stood sealed for a month it is rated or standardized by comparing its gamma-ray activity with that of a radium standard.

The tiny tube, Figure 3, contained about 50 mg. of mesothorium, whose gamma-ray activity was found to be equivalent to 61 mg. of radium element. The five-gallon evaporator contained the stock solution of mesothorium barium bromide from which this finished product was separated in some thirty-odd fractionations. Figures 4 and 5 show two series of evaporating dishes used in intermediate and high-grade systems of fractionation. Silica dishes are used for the most part, the row of small dishes being of transparent silica.

Measurement of Mesothorium

In the early days of refining mesothorium, we measured the activity of concentrates by determining their radium content. All mesothorium material from monazite, it will be recalled, contains some radium. For control work in plant operations, and in making inventory of the values in the crystallizing system, we also relied on radium determinations. But later on it was found that the activity of concentrates and liquors could be measured with a fair degree of accuracy by a more direct gamma-ray method. The latter is now being used almost entirely for measuring mesothorium preparations from ore concentrate to finished product. The time required for making measurements is thereby greatly reduced.

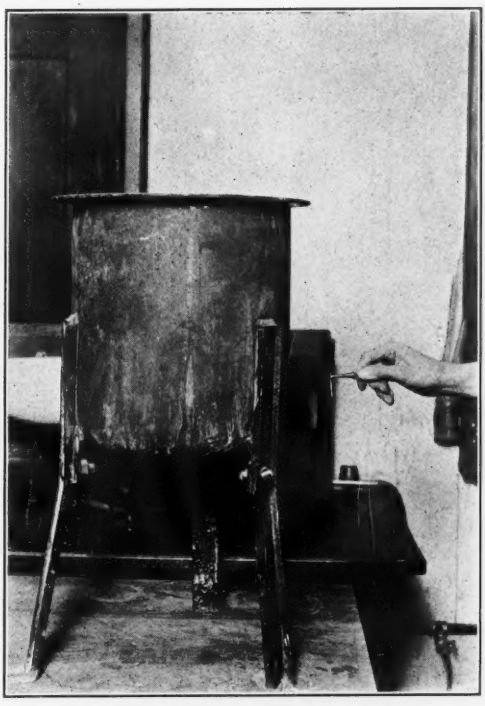

FIGURE 3.—KETTLE OF STOCK LIQUORS AND TUBE OF FINISHED PRODUCT

In making radium determinations in mesothorium concentrates we employed Barker's modification of the emanation method. Briefly the steps are: the weighed sample to be assayed is fused in an eight-inch pyrex test-tube with about ten times its weight of fused potassium bisulfate. This fusion completely de-emanates the sample. The tube is then sealed with a rubber stopper carrying an inlet and outlet tube. The tube is then set aside for a few days for radium emanation to accumulate. Then the tube is clamped in position as shown in Figure 6, and connected in series with a second tube charged with lumps of sodium hydroxide, a micro-bulb containing concentrated sulfuric acid, a tube of cotton and the large air-tight ionization chamber fitted with a Lind type of interchangeable electroscope head. Another micro bulb connected to the air inlet tube serves to indicate the rate at which air should later be admitted to keep the pressure during the

FIGURE 4.—STEEL AND CAST IRON, GLASS ENAMEL EVAPORATORS

fusion below atmospheric. To introduce the accumulated radium emanation into the exhausted chamber, the tips of the tubes are broken off, the current of air is started through the train by partly opening the stopcock of the chamber. The bisulfate is then fused again and heated to low redness. The gentle stream of air sweeps the emanation into the chamber. After standing about three hours the drift of the charged leaf is read.

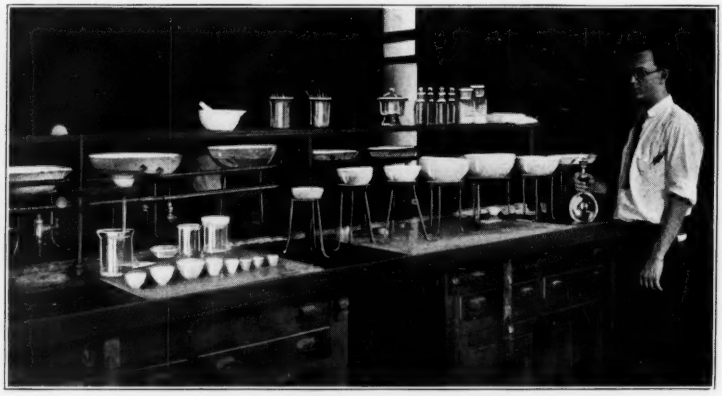

FIGURE 5.—BROMIDE CRYSTALLIZING SYSTEM

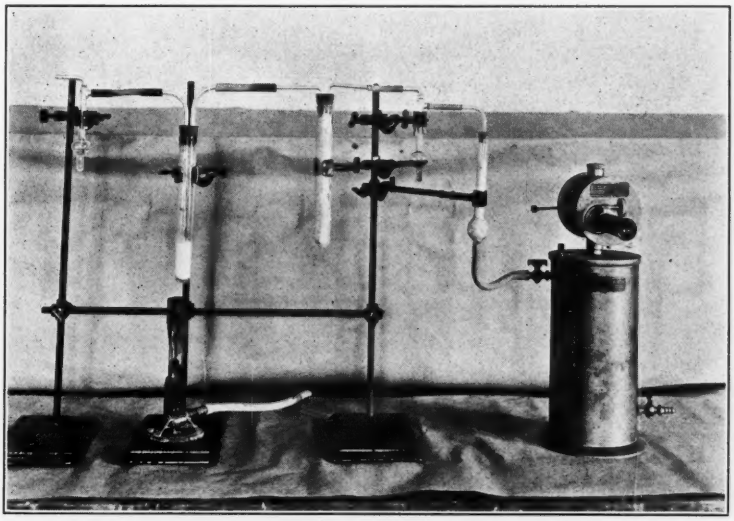

FIGURE 6.—BISULFATE METHOD OF DETERMINING RADIUM

Knowing the natural drift of the leaf and the calibration, a constant of the instrument, the radium in the sample can be computed.

The Gamma-Ray Method. This method involves a comparison of the drift of the charged leaf of the electroscope produced by the gamma radiation from a standard sample containing a known amount of radium, with that of the unknown, the conditions of measurement being, of course, identical. It is obvious that the accuracy of the method is dependent upon the standards used for comparison, and therefore care must be exercised in preparing a set of standards whose radium content is definitely known.

In making measurements, the net drift in divisions per second of the electroscope for the standard may be compared with the net drift in divisions per second of the unknown, taking into consideration such correction factors as are necessary. The unknowns here referred to are not finished specimens of mesothorium, but mesothorium-bearing concentrates, tail liquors, precipitated impurities, and samples of liquors from the larger dishes in the crystallizing system.

For accurate measurements several corrections must be considered: (1) absorption of radiation by the specimen itself, (2) variations in the ionization currents observed resulting from pressure and temperature changes, and (3) correction for the decay or growth of disintegration products not in radioactive equilibrium.

The gamma-ray instrument need not be calibrated in absolute electrical

units. (1) All measurements are made by direct comparison of the unknown with a standard similar to the unknown in (*a*) the order of magnitude of the radium content, (*b*) physical characteristics, thereby obviating the use of correction factors. (2) The more penetrating beta rays were not entirely screened off as is usually done in making gamma-ray measurements, for 10 to 15 per cent of the observed ionization was contributed by beta rays.

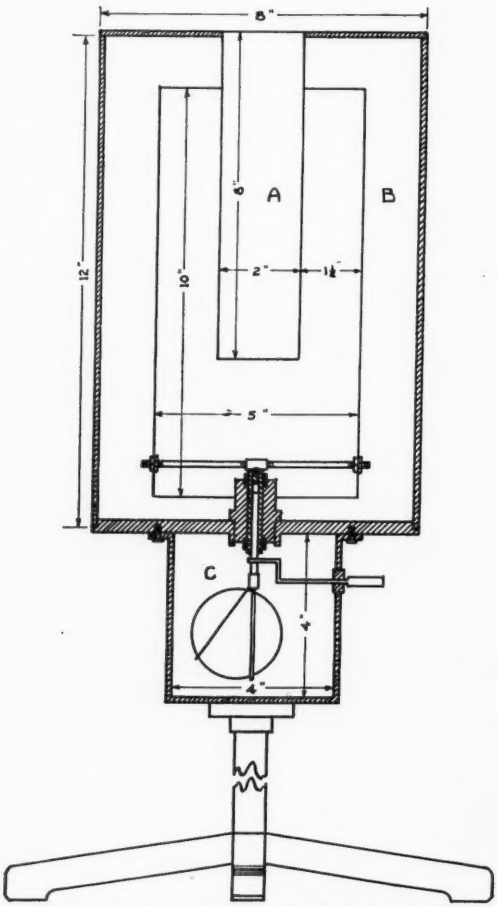

FIGURE 7.—MODIFIED CURIE TYPE OF GAMMA-RAY INSTRUMENT

Several types of electroscopes have been designed for measuring the activity of weakly active materials such as ores and concentrates. High sensitiveness in an electroscope may be secured by (1) reducing the electrostatic capacity of the electrode system, and (2) increasing the volume of the ionization chamber.

The instrument now used in our experiments was patterned after the Curie form modified by Dorsey. It was found that the sensitiveness of the instrument could be quite materially increased by using a different type of electrode and not screening off completely the beta radiation. (Our instrument is fitted with a ring electrode made of brass rodding, instead of a cylinder of brass.) In our method of making comparisons, the activity of the standards used was weight for weight close to that of the samples.

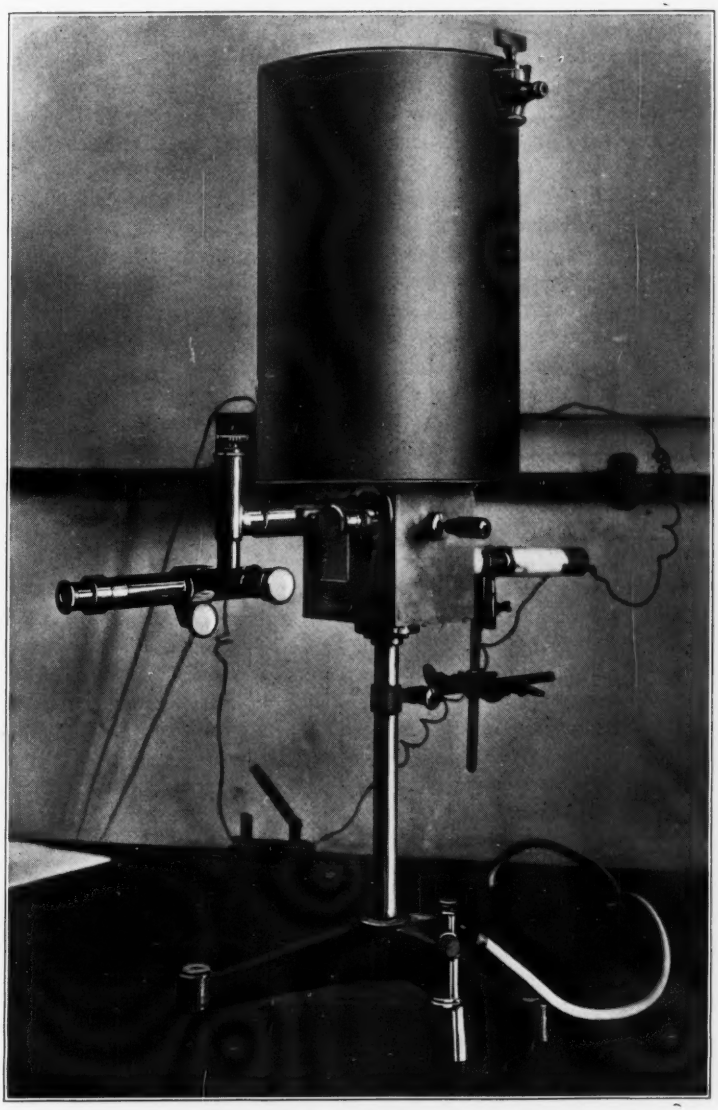

FIGURE 8.—GAMMA-RAY ELECTROSCOPE

There is thus no necessity of screening off beta rays, and correction factors are also eliminated.

A cross-section of the instrument is shown in Figure 7. It may be described as a "triple cylinder, or reëntrant ionization chamber attached to an electroscope." Figure 8 shows the mounting of the reading microscope by means of which it can be adjusted in three planes at right angles to each other.

The sample, hermetically sealed in a pyrex tube or tin container, is placed in *A* and thus occupies a position in the center of the ionization chamber, *B*. The electrode surrounds the sample, equidistant from the outer wall, and the inner wall of the ionization chamber which, in turn, surrounds the electrode. The electrode is supported by the rods which connect it to the leaf system. The leaf system, a single gold leaf, is of the usual type, mounted in amber insulation.

The application of the gamma-ray method, with the instrument just described, to specimens of mesothorium concentrate and other low-grade specimens of radioactive materials has several advantages: (1) the sample used is from 50 to 100 times larger than the amounts used in the radium emanation method (this requirement insures its being more representative of the material tested); (2) the technic of operation is extremely simple; (3) correction factors are practically dispensed with; and (4) a series of determinations may be made on the same sample.

On the other hand the method has one limitation; it is not applicable, with any degree of accuracy, to materials whose mesothorium content is equivalent to less than 10^{-9} g. radium per g.

The radium equivalent of the finished mesothorium is made by comparison of its gamma-ray activity with that of a radium standard. The beta radiation is completely screened off by a lead screen of 1 cm. thickness. Mesothorium is sold on certificate of the U. S. Bureau of Standards, the assigned value being based on gamma-ray comparisons made between 30 to 40 days after the specimen was finally crystallized out and sealed.

Is Mesothorium Refining a Dangerous Occupation?

The necessity for protection of the workers in a refining laboratory for mesothorium and radium from the radiation always present is obvious to any one who has knowledge of the instances in which anemias and leukemias produced by the radiations have resulted in ill health or even death. While such cases are perhaps the exception rather than the rule, the recent cases of radium poisoning resulting from extremely small amounts of radium lodged in the body of the person have drawn attention to the fact that it is of the utmost importance to prevent the entrance of active materials into the body, as well as to reduce the external exposure to radiations as much as possible. Furthermore, the debilitating effects

upon certain workers engaged in the handling of radium emanation in hospital laboratories during little more than a year indicate that exposure to the gaseous emanation products of thoron and radon may be peculiarly effective in producing serious physiological consequences. It is evident that workers in mesothorium or radium laboratories must be watched especially for damage to the organs concerned in the regeneration of red blood corpuscles. The workers in a refining laboratory of radioactive materials are not only exposed to beta and gamma radiations, but while they are in the room they continually inhale the emanations from both radium and thorium, both of which emit alpha rays. The disintegration products resulting from the emanations (see Figure 1) will in part at least remain in the lungs, and perhaps find their way into other parts of the body. These disintegration products are radioactive and are the source of alpha, beta, and gamma rays.

During the period of employment a systematic record of the blood picture should be taken of the workers. Parallel with these tests a series of electroscopic tests for radioactivity acquired by the workers should be taken. The test for the presence of thorium emanation in the expired air of workers is especially sensitive, and by means of it, traces of mesothorium or radiothorium can be detected long before any pronounced changes in the blood count appear.

The first steps, and probably the most important of all, must be taken by the workers themselves in the exercise of care and cleanliness, thereby preventing actual contact of active materials with the skin or their entrance into the mouth and nose. However, there are other dangers which cannot be avoided by such precautions. Are these dangers harmful? It is obvious that workers engaged in the laboratory are exposed to the penetrating radiations from the materials undergoing refining, and to the radiations from radioactive gases and their decomposition products. The alpha rays from solids or solutions in dishes are completely stopped before penetrating more than a few centimeters of air or a fraction of a millimeter of solid matter, and hence can exert no harmful effects unless in direct contact with body tissues. The beta rays are sufficiently absorbed by the solvent and dishes containing solutions to be a source of danger only on the handling of the highest grade materials. For this final stage of the work lead shields should be provided, affording protection for both beta and gamma rays. The gamma radiation can be greatly reduced by chemical methods in removing the radiothorium which accumulates in mesothorium-bearing materials, before fractional crystallization is started. The most penetrating gamma rays from thorium C″ can thus be reduced to practically zero, but it is not practical to remove the mesothorium 2 every day, and since it emits gamma rays the workers will be exposed to this radiation. To reduce this hazard it is well to spread out the dishes containing the

radioactive materials, and in this way prevent a localized center of penetrating rays. In the final stages of refining, the head dishes, when not being heated, should be placed in lead containers 1 cm. thick, molded to fit the crystallizing dishes, and kept covered with watch glasses.

Two other sources of activity, however, may be present in the atmosphere of the laboratory itself. The first of these, active particles of dust in the air, is ordinarily not of importance since throughout the process of refining the salts may always be kept in solution. It is only when the finished products are finally tubed and sealed preparatory to shipment that great precautions are necessary to prevent small particles of the dried and finely divided salt from finding its way into the air, inhaled and deposited as radioactive centers in the lungs. This danger is removed by performing the task of sealing in a good hood with forced draft, and placing a large piece of plate glass between the worker and active material being sealed. As an extra precaution during this operation the worker wears a mask fitted with a dust filter.

The air in the refining laboratory always contains the radioactive gases, radon and thoron. On being drawn into the lungs, the emanations may partially dissolve in the blood stream, but wherever they may be, they continue decomposing and emitting alpha rays, with the formation of solid active deposits. In our refining laboratory here at the University of Missouri, William P. McGavock made a systematic study of this danger by determining quantitatively the amounts of radon and thoron in the air breathed by the workers. The amounts of radon found in the atmosphere of the laboratory, while from one thousand to five thousand times as great as the amounts found in ordinary atmosphere, are still so small that the possibility of harm to the workers from this source is rather remote. The thoron content of the air in the laboratory, however, was found to be considerably more active than the radon. But the greater activity, that is, ionization produced by the thoron in the air, need not be a source of anxiety for, as the tabulation, Figure 1, shows, no long-lived products result from thoron, and in case its effect should become appreciable upon a worker, within a few days after the work is discontinued all active deposits have decayed, thus affording an opportunity for recovery of normal health. As to the actual effects of the quantities of radon and thoron measured upon the workers we found that none have been observed, although a close check of their condition has been kept by means of periodic physical examination, and determination of the blood count and blood pressure. As a result of our observations here extending over a period of ten years, we have concluded that the emanations present in the air cannot be expected to harm the workers, a conclusion further necessitated by the continued perfect health of the five workers who have at different times been engaged in the laboratory. As the work has progressed from year to year

the early tension manifest at times among the workers and their folks has gradually been replaced by a confident feeling of safety.

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Raman Effect. India naturally feels proud of Sir C. V. Raman, the Nobel Prize winner for scientific researches. He is known for the discovery of the "Raman effect," which was first discovered in February, 1928, and announced in a paper read by him before the South Indian Scientific Association, Bangalore. For this he had to go through a series of brilliant investigations. Sir C. Raman illuminated a certain quantity of benzene placed in a flask by means of light from a very powerful mercury vapor lamp of three thousand candle power which emits monochromatic light. The light, scattered in a direction at right angles to the direction of the beam, was then studied. A photograph of the scattered light showed that in addition to the color contained in the original light from the mercury lamp, new colors were, as it were, manufactured by the benzene molecules.

Sir C. Raman explained this phenomenon as follows: "The packet of energy colliding with the molecule mostly gives up a part of its energy to the molecule which is excited and the remainder is exhibited as a modified color." Sometimes a more curious phenomenon happens. If the packet of energy comes in collision with an already excited molecule the light quantum, as it is called, instead of losing anything, relieves the molecule of its extra energy. This phenomenon is exhibited by almost all the molecules, and has thus proved a powerful instrument for the investigation of the inner structure of the molecules. Thus the "Raman effect" has opened up a very prolific and vast field of research.—*Chem. Age*

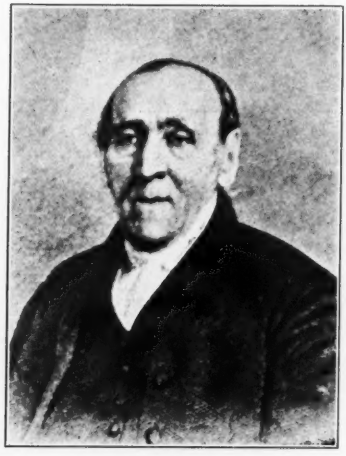
JOHN GRISCOM AND HIS IMPRESSIONS OF FOREIGN CHEMISTS IN 1818–19*

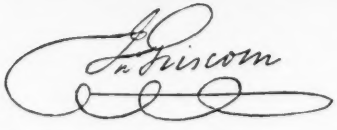
F. B. DAINS, THE UNIVERSITY OF KANSAS, LAWRENCE, KANSAS

John Griscom, a Quaker schoolmaster and teacher of chemistry in New Jersey and New York, published a volume about his travels in England, Scotland, Ireland, and on the Continent in 1818-19. The following article gives his impressions of some twenty chemists whom he met in his year abroad. It is a noteworthy first-hand account of Dalton, Davy, Berzelius, Gay-Lussac, and others who were the "makers of chemistry" in the first quarter of the last century.

. . . . . .

At the beginning of the last century the tide of the chemical revolution began to rise on the shores of the young republic. Priestley, Maclean, and Thomas Cooper from Great Britain, together with Woodhouse, Silliman, and others here, all assisted in arousing a definite and widespread interest in the science of chemistry. Among their disciples few contributed more to this end than the person referred to by George Tichnor as "Professor Griscom, a Quaker chemist of New York, an excellent old gentleman with no small knowledge of the world."





John Griscom (1774–1852) was born at Hancock's Bridge, New Jersey, of Quaker ancestry. His boyhood was spent on his father's farm with such education as he could gain from the local schools.

In 1790 he opened a school for the instruction of the neighbor's children and in 1794 he became principal of the Friends Monthly Meeting School in Burlington, New Jersey, which position he held until 1807. He then removed to New York where he became head of a private school, at the same time continuing his pioneer work in the diffusion of the knowledge of chemistry through his popular lectures. From 1808 to 1831 he conducted in addition a private school of chemical philosophy. He was one of the organizers of the medical department of Rutgers College (1822), where he was professor of chemistry from 1812 to 1828.

* Presented before the Division of History of Chemistry at the A. C. S. meeting, Cincinnati, September 9, 1930.

Griscom's interest in chemistry had the following source as he himself states:

> The study of natural philosophy had afforded me much interest, as I found myself able from the profits of the school and boarders to send to England for a small assortment of apparatus. An air-pump and some other apparatus arrived and yielded much pleasure. Chemistry I had heard much of and I felt now desirous to learn something of the nature of a science which while it unlocked some of the most remarkable secrets of nature, I felt was too profound to be attained or understood in any other way than by professional study with the aid of learned professors and very costly apparatus.

Henry's chemistry was read with no success or comprehension. Lavoisier's chemistry (Kerr's translation) fell into the hands of Griscom. This

> I read with the utmost delight, understood everything clearly, and found it the most interesting pursuit I had ever engaged in. I put the book in the hands of one of my advanced pupils to read as a class book and examined him on every chapter. All was easy, plain, and extremely interesting to us both.

He went to Philadelphia, attended a lecture by Dr. Woodhouse and "was astonished at his experiments and sought his acquaintance."

This inspired Griscom to install a laboratory and he says:

> My worthy friend, Wm. Allen of London, to whom I wrote for apparatus soon responded to the order and along with such articles of apparatus as he well knew best suited to a novice, he sent me a copy of a new edition of his friend Dr. Henry's chemistry, greatly enlarged and better arranged with plates and far more complete as a treatise than Lavoisier's. It was perfectly intelligible and delightful. I was fairly set up and had full employment for all my leisure hours. One of the front rooms of the house was converted into a laboratory and I performed successfully every experiment in the reach of my materials. The more advanced pupils were taught chemistry, perhaps for the first time in any of the common schools in that part of America at least.

This was in 1806 and in the same year he gave public lectures in Burlington on this subject, the beginning of university extension courses in this country.

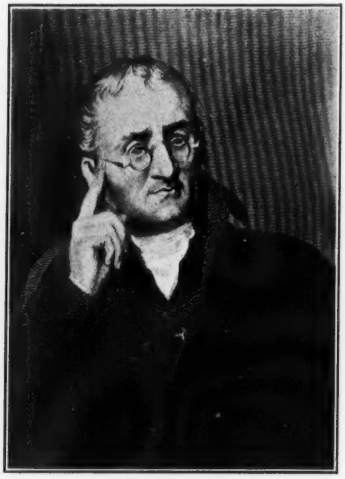
While Griscom was primarily a teacher and exponent of chemistry one incident occurred which gave a slight additional impetus to his lectures: he had written two articles on the chemical examination of mineral waters in the state of New York which were published in the first number of Dr. Bruce's *American Mineralogical Journal* (1810–11). These were reviewed in the *Edinburgh Review* and were spoken of with much commendation.

In 1807 Griscom removed to New York where he was soon in the forefront of every activity, scholarly and eleemosynary. Following the death of his wife in 1818, he resolved to visit England and the Continent in order to make the personal acquaintance of the scientific men whom he knew by their writings and to study at first hand the industrial processes as well as the administration of hospitals, insane asylums, and other methods for the relief of poverty and suffering.

In his "A Year in Europe"[1] are the noteworthy observations of this keen Quaker schoolmaster who was so interested in everything about him.

The excerpts from this book have mainly to do with chemists, since for us his first-hand impressions of many of the men who contributed so much to the advance of chemistry in the early years of the last century are of especial interest.

Griscom sailed from New York, April 6, 1818, on the ship "Pacific" and after a stormy and unpleasant voyage landed in Liverpool on May first.



JOHN DALTON

Here he called on Wm. Roscoe, the merchant, author, and publicist grandfather of Sir Henry E. Roscoe, the chemist, with whom he discussed the penal codes of England and America. From there he went to Manchester, where both the cotton mills and Dalton were equally attractive.

After visiting another factory, in which a kind of cassinet is manufactured, Dr. F. and myself were conducted to the rooms of John Dalton, so well known for his acute and extensive researches in chemical science. We found the philosopher at his desk, surrounded by his books, his boxes, and his apparatus, chemical and philosophical, all in "delightful confusion." He is a member of the society of Friends, of plain unaffected manners, and highly esteemed in social life. His apparatus is very simple, and chiefly employed in experiments of research. So profound have been his investigations, and so high is his reputation as a chemist and mathematician, that the literary and philosophical society of this place have elected him their president. He is a bachelor of about fifty.

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[1] "A Year in Europe, Comprising a Journal of Observation in England, Scotland, Ireland, France, Switzerland, the North of Italy, and Holland in 1818 and 1819," by John Griscom, Professor of Chemistry and Natural Philosophy in the New York Institution; Member of the Lit. and Phil. Society of New York, etc. In two volumes, pp. 520, 562, New York, **1823.**

The copy used by the writer (F. B. D.) is a presentation copy from John Griscom to Professor B. Silliman, and contains occasional pencil annotations by that staid professor. Silliman had published (1810) a journal of his travels in England, Scotland, and Holland in 1805–6.

In a letter in 1822, Silliman speaks of dining with "my good John Griscom, a brother chemist and lecturer; and his mild and soothing manners and modest good sense formed a pleasant relief from a rather stormy interview with an English traveling geologist and his arrogant assumption of superiority over American geologists."

I breakfasted on the 10th at Dr. William Henry's,[2] in company with Dalton. The Doctor's family being absent, he boiled the eggs for us himself, and treated us with great ease and kindness. The conversation of two men so deservedly distinguished for science could not but be highly interesting. It turned upon certain points of chemical theory—chlorine, acidity, alkalinity, etc. They are neither of them entire converts to the new doctrine of chlorine. Dr. Henry, with whom I afterward dined, conducts a chemical manufactory, celebrated for the purity and perfection of the articles it produces.

From Manchester Griscom journeyed to London, spending a night in Oxford where he was much struck by the beauty of the colleges, but some drunken students gave him a very unfavorable impression of the morals of the university.

The entrée to scientific London was gained through Sir Joseph Banks (1743–1820), the Nestor as well as Mæcenas of British worthies, who fifty years before had sailed as a naturalist with Captain Cook in his first voyage of circumnavigation.

I was early introduced to the weekly levee of Sir Joseph Banks, and have several times availed myself of the advantages of such an introduction. It is a focus, where one may be almost certain of meeting with the most distinguished scientific men of the metropolis, and with learned strangers. At his house a stranger must be introduced either by a letter or by an accustomed visitor; but after the first visit, he is at liberty to go as often as he pleases, either to the evening conversazione, or to a weekly breakfast, at ten o'clock in the morning.

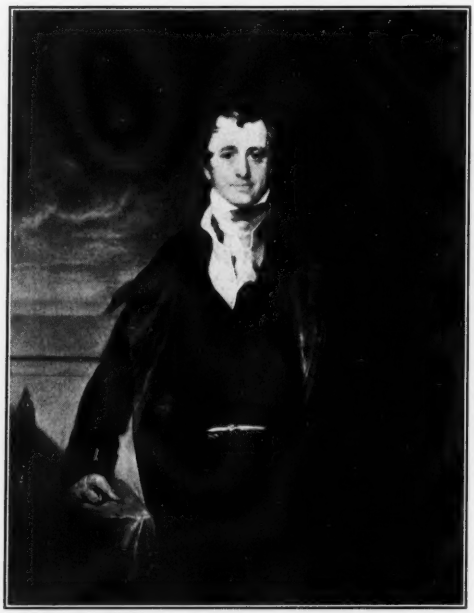
WILLIAM HENRY

Here Griscom

. . . . met with Sir Humphry Davy, a circumstance which I considered fortunate, for he informed me that the next day he was to leave London for the Continent, where he expected to remain a long time. From the just celebrity of his name, an interview with him was desirable. His person is rather below the middle size, his countenance open, his manners lively and animated, and his conversation flowing and vivacious. Having married a lady of fortune, he no longer officiates as a lecturer, but his attention is still occasionally directed to chemical research and experiment; and from his known ardour, and his being still in the middle period of life, it may be hoped that the brilliant career of discovery, which he commenced at a very early age, has not yet arrived at its termination.

Davy (1778–1829) who was now at the height of his fame, had recently completed his experiments on the safety lamp which bears his name. In a

[2] William Henry (1774–1836) was a prolific author, investigator, and chemical manufacturer. In 1808 Silliman published the first American edition of his "Chemistry." E. F. Smith, "Old Chemistries," McGraw-Hill Book Co., Inc., New York City, 1927, p. 43.



HUMPHRY DAVY

tion of Brande's "Manual of Chemistry" appeared in America in 1821.

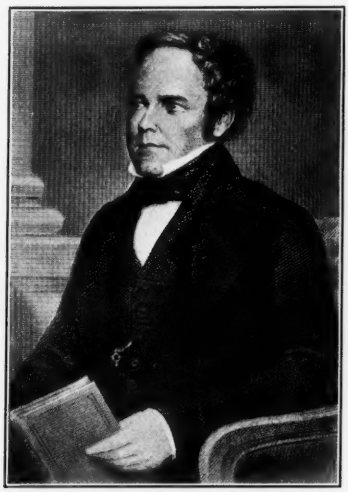
Griscom described the Royal Institution as follows:

> It contains, in addition to the apparatus and lecture room, a reading room, furnished with periodical publications and books; and a large and valuable library of historical, classical, and scientific works. One room of the institution is appropriated to minerals, the collection of which is extensive and valuable. The chemical laboratory, in the basement story, is exceedingly well constructed. Adjacent to it is an arrangement of seats for private lecture, and in an apartment on the same floor, is the grand galvanic battery, which has been so powerful an instrument of discovery, in the dexterous and skilful hands of Sir Humphry Davy. It contains about 3000 double plates, arranged in troughs of Wedgwood porcelain.
>
> The theatre, or principal lecture room,

letter to his mother in the summer of 1818, he speaks of his departure from London (referred to by Griscom).

> We are going on a very interesting journey. I am first to visit the coal miners of Flanders, who have sent me a very kind letter of invitation and of thanks for saving their lives.

Later Griscom visited the Royal Institution, though he does not seem to have met the modest Faraday, at that time assistant to his famous master, Davy, who had been succeeded in the chair of chemistry by Wm. Thomas Brande (1788–1866), a lesser but energetic light. An edi-

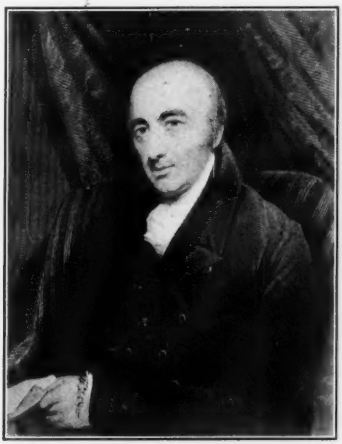


WM. THOMAS BRANDE

is semicircular, and will accommodate 700 persons, with a gallery around it which will hold 200 more. The chemical lectures are delivered by Professor Brande, who, considering the difficulty of the path which he had to tread, in consequence of the extraordinary ingenuity and eloquence of his predecessor, sustains the reputation of his department with great credit. The number of his auditors, when I have attended, has been about 200, more than half of who were females, apparently of the most respectable classes of society. The chemical and philosophical apparatus is of the first order, and the experiments are, accordingly, rendered particularly attractive.

Griscom was the guest of a committee of the Royal Society on their annual visit to the Royal Observatory. While the group "inspected the instruments," the important business seems to have been the "excellent dinner," which was served at an inn on the banks of the river. Here

> . . . . the graver features of philosophy softened into the ease of social familiarity, and conversation flowed without restraint. It was a union of men of the highest order of intellectual acquirements, and under circumstances favourable to the sympathies of the heart. It would be impossible perhaps to assemble an equal number of men, of any one nation, in which should be comprised a greater amount of profound knowledge in every department of science and learning.



WM. H. WOLLASTON

The group that Griscom thus met comprised some notable names. Sir Joseph Banks was president of the Royal Society. Of Wollaston (1776–1828), the discoverer of palladium and rhodium, the visitor remarks, "Few philosophers of the present day stand higher in the scale of scientific merit. His physiognomy is indicative of great acuteness, as well as strength of reflection." The work of Thomas Young on sound and light is classical. William Allen and Thomas Pepys had published a joint paper on the quantity of carbon in carbon dioxide and in the nature of respired air. Hatchett, the discoverer of columbium or tantalum, was there, as were James Watt, Herschel and Englefield, the astronomers.

Compared with Paris, London was relatively barren in chemical laboratories and hence it is all the more surprising that the unfortunate Accum,[3] the mentor of Silliman and Dana, etc., should not have been mentioned by Griscom.

[3] BROWNE, "Life and Chemical Services of Frederick Accum," J. CHEM. EDUC., 2, 829–51, 1008–34, 1140–9 (1925).

On his return from the continent in 1819, he mentions a visit to Guy's Hospital, "the principal school of medicine in London," where he "was present at a lecture on chemistry by Dr. Marcet, a prominent physician who is one of the teachers in this school," though "his well-equipped laboratory is in his own house." Griscom thinks that it is "creditable to the impartiality of the managers (of Guy's Hospital) that a Swiss gentleman none too perfect in English should be chosen for this position."

Previously in Geneva he had met this Dr. Alexander Marcet (1770–1822), the pupil and correspondent of Berzelius, and his wife, Jane Haldeman Marcet[4] of whom he says that

Alex. Marcet

> . . . . she is known as the very sensible and judicious author of "Conversations on Chemistry,"[5] which was written, as she informed me today, just after her marriage, and before the birth of her children, of whom she has two, both daughters, about ten and eight years of age. She possesses a strength of understanding much above mediocrity, as her conversation, as well as writings, bear sufficient testimony.

Our Quaker friend, while open-minded and progressive, cannot avoid a little surprise at any evidences of initiative, learning, and originality among his lady acquaintances. Thus he naïvely describes his guide through the Exeter cathedral, as a "female who explained with singular dexterity and correctness the various things about which we wished to be informed."

One only of the many industrial plants visited by Griscom can be mentioned, and that the Westminster gas factory, where he was impressed with the great superiority of this kind of light to that from oil. It shows the surprising advance that had been made in a few years, since Silliman in 1805 describes as a great curiosity an apothecary's shop in Piccadilly that was lighted in a very beautiful manner by heating fossil coal in a furnace.

[4] SMITH, E. F., "Jane Marcet," in "Old Chemistries," p. 64.

[5] "Conversations on Chemistry" was one of the strongest influences in interesting young Faraday in chemistry. In America it had a great run in many editions and was possibly the only chemistry in English written by a woman until the appearance of "Chemistry for Beginners, designed for common schools and younger pupils," by MRS. A. H. LINCOLN PHELPS (New York, 1839).

Leaving London in September, 1818, Griscom crossed the channel to Dieppe, where he had the experience in the shop of a barber of being "shaved by his daughter, a neat girl of fifteen, and we could not but acknowledge that she handled the razor with much dexterity." A long stage ride via Rouen brought him to Paris which was a new world to the quiet-minded Friend. He looks at the statues, busts, and pictures in the Louvre and remarks:

> The first effect is astonishment at the freedom of the exhibition. There is nothing in statuary or painting which shocks the female delicacy of the French. The public gardens abound in statues which, in America, are only placed behind screens in our exhibition rooms.

His days in Paris were strenuous, filled with visits to museums and hospitals, and to the scientists of that city. For recreation he witnessed one evening the ascent of a balloon from the gardens of Tivoli. When the silk bag was completely inflated with hydrogen,

JANE MARCET

> .... the intrepid Madame Blanchard mounted the car suspended from the balloon, standing upright in it, holding in one hand a white flag and in the other a lighted match. Then, at a signal given, the cords were detached, and, still standing upright in her car, she rose with a movement which combined more of sublimity and gracefulness than any thing I ever beheld within the compass of human art. When she had risen fully above the tops of the trees, she applied her match to the fireworks, and in a moment she was enveloped in fire, smoke, and thunder; but at such a distance below her, as to do no injury to her frail vehicle. The effect was truly wonderful. To see a human being, and that too a delicate female, suspended in the air to a ball, and scattering around her fire and thunder, and then rising, with majestic grace, into the upper regions of the atmosphere, and sailing, with the velocity of an eagle, cannot fail to produce the liveliest astonishment. This ascent, we were informed, was the seventy-fourth flight of this skilful aeronaut.[6] There would seem, therefore, to be scarcely more danger in making a journey through the atmosphere, by means of a silken bag, filled with inflammable air, than in a voyage at sea.

The sponsor of Griscom in Paris was Count Berthollet (1748–1822) who occupied here the predominating position Sir Joseph Banks held in London. The friend of Lavoisier, Berthollet had renounced the phlogiston theory in

[6] The next summer Mme. Blanchard was killed when the gas in the balloon was inflamed by the fireworks.

1785. Among his many achievements were the discovery of chlorates, the use of NaOCl as a bleaching agent, and the fundamental researches on chemical affinity.

I was introduced today to the Chambers of the Institute (the center of scientific life of France), by Count Berthollet, and attended a sitting of that body. They occupy two large rooms, the walls of which are completely filled with books, forming a very extensive library. One of the rooms serves as an antechamber, in which the members assemble and converse, prior to the sound of the president's bell, which convenes them in the other room. I was struck with the general physiognomy of this learned body. A stranger, without knowing who or what they were, would certainly pronounce them to be men of strong sense. I am inclined to think that the French countenance is more expressive of character than the English. A narrow table extends along the four sides of the room, around which the members sit, facing each other.

CLAUDE LOUIS BERTHOLLET

Here he met the chemists Gay-Lussac, Thénard, Chaptal, and Berzelius. Griscom makes this comment at another meeting of the Institute:

The president for the day was De Rossel. The two perpetual secretaries, Delambre and Cuvier, sat on his right; and the vice-president, Vauquelin, on his left. The minutes and correspondence were read, and then several papers by the members; among which was one by Thénard. The sittings are well attended. It was very interesting to see men whose names make so conspicuous a figure in modern science, assembled at a board, which has done so much to extend the progress of useful discovery and improvement. Some of them are very old, particularly Häuy, Lamarc, Lacepede, and Berthollet.

The personal side appealed to Griscom as the following account well shows:

Berthollet, whose name is so eminent as one of the most scientific reformers of chemistry, has long resided at Arceuil, a considerable village about three miles south of Paris. He enjoys an ample fortune, and lives in a style of real elegance. I met at his table today Professor Brongniart, his wife, and mother; and Jomard and his wife. These gentlemen are both eminent in science, the former in mineralogy and geology, the latter in the antiquities. The treatise of Brongniart is much esteemed in England and America, as well as on the continent. With so many females—so many wives and husbands, this was, of course quite a dinner *en famille*. The saloon in which I found the party assembled, was richly furnished. On the middle of the carpet were depicted, by means of the loom, the portraits of two lap dogs, which were then sporting about the room, and which appeared to be great favourites with their master.

Berthollet has long held the title of count. Though advanced in age, he generally attends the sittings of the Institute, and takes an active share in its duties. He has a good private laboratory, which still serves to amuse him. His wife is an exceedingly worthy and estimable person. They have no children living. We sat down to dinner about four, in a room remote from the parlour in which we had assembled. The table was plentifully served in the French manner, which requires a much more frequent change of plates than an English entertainment. The servants were so dexterous in the removal of dishes, that no time was lost by the numerous changes. I have become quite reconciled to the French fork, which is always a large silver instrument with four or five prongs. The knife is small, sharp pointed, and intended for no other purpose than dividing the food. The first concern is to cut up all the meat on the plate, the knife is then laid aside; the fork is taken into the right hand, and a piece of bread in the left. This process, though at first inconvenient, now appears to me to be preferable to the use of our broad and heavy knives. There was a blending of taste, simplicity of manners, and kindness in this little party at Berthollet's, which was highly pleasing. The conversation was lively, and frequently general, though I thought, upon the whole, it lacked something of the perfect ease and sociability of an English dinner. But this impression I admit may have been occasioned by the circumstance of my being so much less habituated to French society.

Count Berthollet told me that he had adopted the new theory of chlorine, and renounced the views which have been so long entertained by chemists, and of which it is well known, he was himself the author, regarding that substance as a compound of muriatic acid and oxygen. "It is to Dalton," he said, "the merit belongs, of having laid the basis of the atomic theory." It is thus, I may add, that the candour of a noble mind is ever ready to manifest itself, in justice to others.

PIERRE AUGUSTE ADET

Griscom had as guide and counselor Pierre Auguste Adet,[7] chemist, man of the world, and politician who had spent some years in America as French Ambassador.

Adet called and took me to see Vauquelin, who, as one of the professors, resides in the Garden of Plants. He was not at home; but we had a long conversation with two sprightly old ladies who live in the same house; both of them sisters of Fourcroy,[8] the late celebrated chemist. One of them talked incessantly for half an hour;

[7] For an interesting recent account of Adet see NEWELL, "Pierre Auguste Adet," J. CHEM. EDUC., 8, 43–8 (Jan., 1931).

[8] ANTOINE FRANCOIS FOURCROY (1755–1809), a former professor in the "Garden of Plants," was a distinguished author, teacher, and opponent of the phlogiston theory. With Lavoisier and Guyton de Morveau, he issued the "New Methods of Chemical Nomenclature" in 1787.

giving me a more complete specimen of female volubility, than I ever had before. Her subjects were all of a domestic nature, relating to individuals of their acquaintance; but her animation and fluency went very much to confirm me in the opinion that the French language is better adapted than our own to the rapid and easy movement of the organs of speech.

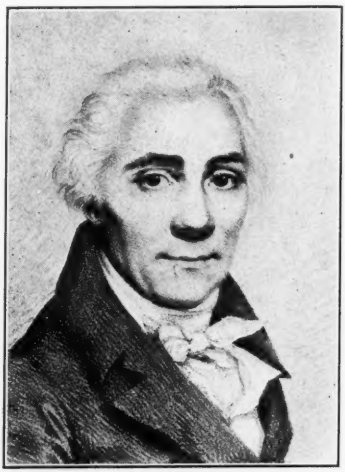
A. F. FOURCROY

Two days later

Adet called again. We found Vauquelin at home, and had a pleasant conversation with him and the old ladies. He has a remarkably mild and agreeable countenance. (*Later Griscom heard him lecture.*) Adet informed me that Lavoisier's death (one of the darkest deeds of the revolution) was very much owing to his holding the station of farmer-general, an office against which the republicans discharged their most malignant venom. Had he been willing to take the advice of his friends, his life might have been saved; but relying on his own unblemished integrity, he persisted in a course of action which brought him to the guillotine. It is a fact that Robespierre would not even give him time to finish an interesting experiment, by which he hoped to deduce an important chemical truth.

Dr. P. introduced me, in the course of the day's round, to Thénard,[9] the able professor of chemistry in the College of France. We found him in his laboratory, engaged in experiments. He stated to us some discoveries he had just made relative to the super-oxygenisement of acids, by means of barytes, and the evidence of the discharge of the additional oxygen, by the agency of silver.

Jöns Jakob Berzelius (1774–1848), the great Swedish scientist, occupied in chemistry the omniscient position that Humboldt did in natural science; a great teacher and investigator, his labors brought order into the chemical world.



N. L. VAUQUELIN

[9] LOUIS JAQUES THÉNARD (1777–1857) was a pupil of Vauquelin and Berthollet. He discovered H_2O_2, BaO_2, CaO_2, etc., and collaborated with Gay-Lussac in the isolation of sodium and potassium by reduction other than by electrolytic means, etc. A celebrated teacher and writer.

During his visit to Paris in the fall of 1818 (which coincided with that of Griscom) he doubtless spent hours in discussing with Humboldt and Gay-Lussac his theories of chemical proportion and his new table of atomic weights.

M— called this morning, and went with me to see Professor Berzelius, of Stockholm, who has lately arrived here with the Swedish minister. He is rather a young man, of open and pleasing address, and of social easy manners. We spent an hour and a half with him in conversation on subjects of science. He showed us a portion of the new metal called by him selenium, and exhibited to us some of its properties, by the blowpipe. He carries with him a neat collection of instruments, for the analysis of minerals in the dry way, done up in a folding leather case of small compass. He intends to remain in Paris all winter. After attending a lecture of Professor Brongniart, I accompanied Berzelius to the house of Count Bournon, who has long been esteemed as one of the best mineralogists in France. He was forced by the revolution to England, where he received that attention which his scientific merits deserved. He published, while in England, his famous work on "Carbonate of Lime," in 2 vols., 4to.

At the house of the geologist, Alexander Brongniart, Griscom first met the author of "Cosmos," the great Alexander v. Humboldt (1769–1859), who like Franklin was "many-sided in his intellectual activities."

ALEXANDER VON HUMBOLDT

This celebrated traveller and philosopher is still in the vigour of health. His age does not, I should think, exceed forty-seven. He has a round full face, marked with smallpox, and blue eyes. He might easily be mistaken for a respectable German farmer, until conversation displays the treasures of his mind. He said a great deal, and as it appeared to me, in a manner indicating rather more of confidence in his own opinions that would have become any person who had seen less. But is it surprising that a man who has been so able and faithful an observer should become habitually confident? It is, perhaps, the natural tendency of the love and practice of foreign travel to inculcate the feeling of,

"I've seen, and sure I ought to know."

We know, however, that dogmatism and self-confidence are by no means confined to travellers.

On another occasion Griscom met Humboldt, who

. . . . was ripe for conversation; but instead of enlightening us from the rich stores of his Asiatic or American recollections, he entered warmly into politics, and discussed, with Baron Cuvier, the prevailing measures of the cabinet. I was surprised

to see these two great naturalists take so deep an interest in the local politics of the city and country.

Brongniart is an able geologist, as his researches, in connection with those of Cuvier, on the stratifications of the Paris basin abundantly prove. He was much pleased with a collection of fossils he had just received from Professor Silliman of Yale college. He finds the same organic remains, in the same mineral substances, from whatever country it may be derived.

Next to Berthollet, Jean Antoine Chaptal (1756–1832) was the oldest in the group of French chemists. He had been Professor of Chemistry at Montpellier, a soldier in the trench, then the successor of Berthollet in the School of Arts. Later he was Minister of the Interior, a member of the Senate, and was enobled by Napoleon.

J. A. CHAPTAL

I spent half an hour this morning with Count Chaptal. The deep interest he takes in the progress of manufacturing industry in France, and the scientific skill and personal effort he has exerted to promote the chemical arts, are well known. Although his name is associated with that of Lavoisier and many others, as the founders of modern chemistry, he has not the appearance of an old man. He spoke heartily of America and was lavish in his praises of Washington. He once received a letter from him and was much gratified with the sentiments it contained.

He assured me that his manufactory of sugar from beets is still profitable. He carried it on I believe upon a large scale. The residuum of the root after the juices are pressed out, is advantageously used in fattening cattle. He shewed me a loaf of the sugar, which in colour and taste was equal to the best cane sugar equally refined.

As Griscom remarks, Chaptal was of enormous service to France in her period of "storm and stress" in developing her chemical industries and other applications of chemistry. He also wrote a very successful textbook which ran through many editions in French, German, and English. The first American edition was dated, Philadelphia, 1801. In view of the present-day view regarding the atom the following quotation is noteworthy.

In the conclusion of a chapter on the alchemists, Chaptal says—

I must observe that chemical phenomena become so wonderful; the torch of analysis has enlightened us to such an extent; we now decompose and reproduce so many substances that ten years ago were considered with equal probability as undecomposable as gold is now thought to be; that no chemist can take upon him to affirm that we may not arrive at the art of imitating nature in the formation of metals.

Joseph Louis Gay-Lussac (1778–1850) was the most able of the chemists that Griscom met in Paris, with the exception of Berzelius. In 1804, with Biot he made the celebrated balloon ascension for the purpose of gathering scientific data; known to the undergraduate for his "gas laws" he also discovered the first radical "cyanogen, recognized iodine as an element and laid the foundations for volumetric analysis." Griscom says regarding Gay-Lussac:

J. L. GAY-LUSSAC

I received a visit in my room from Gay Lussac. He is a much younger man than his reputation would have induced me to expect. His person and manners are interesting, and his talents as a chemist and philosopher, of the first order. He appears to be interested in the success of elementary schools. It will require, he observed, 30,000 schools to supply all France, and there is yet established but about one-sixtieth of that number.

In the following selections, Griscom sums up the impressions which some of the men whom he had met made upon him as chemists and lecturers. It gives an unusual and unique picture of some of the men who had a great influence on American chemistry one hundred years ago.

J. J. BERZELIUS

After filling up the morning of the 30th with an attendance of lectures, and a visit to the institute, I joined Berzelius and Thénard in a dinner party at Gay Lussac's. His residence is on the south side of the town, rather remote from the schools in which he so ably delivers his courses of instruction. He is professor of natural philosophy (*physique*) conjointly with Biot, in the College of France, and of chemistry in the Polytechnic school. His professorships are worth 9500 francs. He is, besides, employed by government, as an inspector in the manufactory of gunpowder, and is one of the editors of the *Annales de Chimie*, a monthly journal of extensive circulation. His talents for experimental investigation, and logical deduction, are of the first order,

and there are few persons to whom modern chemistry is more deeply indebted. His age, which I should judge to be about forty, is far behind his reputation as a philosopher. His wife is a neat person, even for a Frenchwoman, and of amiable and engaging manners. The remarks I have made, with respect to the scientific merits of Gay Lussac, apply, with nearly the same force, to the other two gentlemen last named. The authority of Berzelius in chemistry, particularly in the laws of inorganic matter, is deservedly very high. As a mineralogist, he is, probably, much superior to either; as a physician, in the French sense of the term, he is doubtless much below Gay Lussac. He enjoys a high consideration in the French Institute, (or Royal Academy of Sciences), and is one of the chief secretaries of the Swedish Academy. Thénard has less acumen, and his mind is less vigorous than either; but he is patient, laborious, and judicious. He has done much for experimental chemistry, and is the author of a treatise which bids fair to become a standard in the chemical schools of the continent. He fills his station, as professor of chemistry, in the College of France, with much ability. His papers before the institute are listened to with lively interest and attention. The union of three such men, at a private dinner table, was a treat, which needed not the stimulus of French cookery, refined and excellent as it is, to render it highly agreeable.

LOUIS J. THÉNARD

Chemistry in the medical school is taught by Vauquelin and Deyeux. Of these, I heard only the former. He has been long distinguished as super-eminent in the art of chemical analysis. To his patient and ingenious labours, continued from the dawn of modern chemistry to the present time, the science is deeply indebted. His voice and delivery are too feeble and indistinct for a good lecturer, and his innate and characteristic modesty, prevents him from making those exertions which can alone secure the whole attention of his audience. He is assisted by an able operator, whose experiments constitute much of the attraction to this part of the medical course. Thénard is the chemical professor in the College of France. He delivers also a popular course in a room of the old Collège de Plessy, Rue St. Jaques, an apartment badly calculated for so important a purpose. The room is too small, and has but few conveniences. It is generally filled to overflowing nearly half an hour before the lecture commences. Thénard, on the whole, is an able professor. His style is plain. He sometimes aspires to elegance, but does not always succeed, even to his own satisfaction. I have known him, after having nearly finished a sentence, stop, and after saying, with apparent vexation, "Gentlemen, I express myself badly," begin the sentence again, and go over the explanation more to his liking. There is rather less evidence of taste and genius in his style of lecturing than in that of some others, but he is well acquainted with his subject, and stands remarkably well with his class.

Gay Lussac lectures in the same room, but on different days. His province, in this college, is natural philosophy (*physique*). There is, perhaps, greater anxiety to hear him than Thénard. He is, in all respects, an able professor, except that his

utterance is too rapid for the clear comprehension of some of his auditors. He enters into the spirit of his matter, and evinces a profound acquaintance with the principles of experimental science. He uses very short notes, mere memoranda of the divisions of his lecture. His manner is sufficiently animated, though he confines himself very closely to his text. His language is precise and correct, but it does not lay claim to eloquence. He is quick in his perceptions, and rigid in his deductions. He is a man of undoubted genius, and is excelled by very few, either as a philosopher or lecturer. I regretted, however, to find that even with the two last-named very popular teachers, national prejudice has so undue a hold upon their minds, as to make its appearance in the lecture room. There was an obvious and continued effort to refer the great discoveries of science, as far as it could possibly be done, even by a strained construction, to the French origin, and a corresponding disinclination to admit the claims of English philosophers. This is a kind of vanity that is utterly beneath the dignity of philosophy, and can be accounted for, as I conceive, only on the ground of an early and settled prejudice, embodied, probably, with the precepts of the nursery, and cherished by the whole tenor of education.

Brongniart, also, delivers his course on mineralogy, in this building. The venerable Abbe Häuy, who is associated with him, only gives a few opening discourses, and leaves the subject to the disposal of his able coadjutor. Brongniart is animated and perspicuous. He is an excellent mineralogist. His class is not large; for unless the specimens exhibited, are suffered to be handed round, which is here seldom permitted, the subject is divested of its chief attraction, and of much of its utility. The display of a specimen, in the professor's hand, is of little service, except to those who are contiguous to the table. By entering into the economical uses of the minerals, as well as their geological relations, he furnishes his class with a rich fund of information.

M. J. B. ORFILA

M. J. B. Orfila (1787–1853) was the founder of modern toxicology. His "Practical Chemistry" (Philadelphia, 1818), edited by John Redman Coxe of the University of Pennsylvania, gave in a concise form the methods of preparation of chemical compounds and means for their identification.

Among the numerous private teachers of science, the most popular, in chemistry, is Dr. Orfila, and in natural philosophy, M. Tremere. The former is a professor of very considerable merit, and is accordingly attended by a numerous class, notwithstanding that his room is in a close, dirty part of the town, the ascent to it up three pair of stairs, narrow and crooked, and the room itself, in a garret, coarse and inconvenient. The view he takes of chemical science appeared, as far as I observed it, to be rather superficial, and I was surprised to find him unacquainted with several important results, obtained by English chemists, in relation to the subject he was treating of. Prejudice, or even neglect to inquire into the merits of other people, is, in no case,

less excusable than in one who undertakes to explain the actual condition of a science, and to do justice to the merits of those, of whatever nation, whose genius had been devoted to the discovery of its truths. The results to which I allude, were not of very recent determination. Orfila, as far as his knowledge extends, is a perspicuous and impressive lecturer. Tremere has a splendid and costly apparatus, and is familiar in the use of it; but his manner is feeble, though he frequently aims at great earnestness and importance.

Few worthwhile sights in Paris were omitted by Griscom. The skilful workmanship of the French artisans can be seen today in the apparatus of Lavoisier that has been preserved.

In one of the rooms of the Conservatory of Arts, for instance, is a model of a chemical laboratory, in which there are not only furnaces, bellows, crucibles, and other apparatus, all of Lilliputian size, but also little images of men, a few inches high, equipped with their aprons, and placed in attitudes of various chemical employments. Such representations, though they may be considered as the play of science, are still useful. A simple inspection of those little models will furnish, to a person unacquainted with them, a more correct idea of the operations they are meant to illustrate, than it would be possible to derive from the plainest verbal description, even when accompanied by plates.

EARLY CARTOON OF M. J. B. ORFILA

One of the high lights of the year was a visit to Lafayette at La Grange.

I have met with no person in France whose address is more frank and engaging than that of the Marquis de La Fayette. His eyes are full and glistening, his complexion florid, and the expression of his countenance is that of benevolence, operating on the strong and lively emotions of his heart.

Space forbids quoting Griscom's accounts of the following men of science in other fields than chemistry, viz.: Baron Curvier, the naturalist; Biot, the physicist; Arago, the astronomer; Abbe Haüy and Count Bournon, mineralogists; and Charles "the old and veteran professor of philosophy."

From Paris, Griscom made his way into Switzerland via Lyons, where he was deeply impressed with a hospital in charge of the "Sisters of Charity." In this institution "he found that some of the elder sisters fill the higher and more elevated office of apothecaries." In the course of his journey, he notes the cultivation of Indian corn but it is "a meager crop in this part of the world."

In Switzerland the mountains, people, and schools were all of intense

interest to our Quaker traveler. A long account is given of the "Institute d' Education" of Fellenberg at Hotwyl and the school of Pestalozzi at Yverdun with pen pictures of the two men and their methods of teaching. Of the latter he says,

> If his personal talents, address, and management were equal either to his genius or his zeal, his influence would have been much greater than it has been. Nevertheless, his life and labors will, I fully believe, be hereafter regarded as a most important epoch in the history of education.

At Geneva, he lodged in the fourth story of the "Balances d' Or." On dining at the table d' hôte, he was

> . . . . regaled with music rendered by a man with a violin and a woman with a guitar, who accompanied her instrument with her voice. On request they gave the national or Swiss air called the "Rans de Vache" which is said to produce so great an effect on those who are absent from their country. The note is soft and tender, and, I doubt not, produces an immediate association of ideas which may powerfully affect the nervous system.

Here naturally the university was a center of attraction and he became the warm friend of Prof. M. A. Pictet (1752–1823), whose interests were in physical science rather than in chemistry alone. Pictet held a high position in Geneva not only on account of his learning but because of his deeply religious character and philanthropy. Pictet, like Griscom, was a friend of Wm. Allen, the London Friend who was not only a chemist and pharmacist but a great social reformer.

> I attended this morning a lecture by Professor Pictet on galvanism. He conducts his course with little apparatus, and that which he does use belongs mostly to himself; the college not being in a condition at present to provide itself with instruments. He was therefore obliged, in illustrating the facts of galvanism, to use diagrams drawn on a blackboard with chalk. A board of this kind covers the professor's table. Its surface is preserved by a folding lid or cover, which is fastened by a lock. He did not enter much upon the theory of galvanism. He showed the students Dr. Wollaston's miniature battery, and the eagerness with which they endeavoured to see and comprehend its action, sufficiently evinced the advantages of experimental illustrations over a mere verbal definition, however correct and elaborate. The professors in this college question two or three of the students upon the principles of the last lecture, at the commencement of the succeeding. The names of those to be questioned are drawn by lot, so that none knows upon whom it will fall. The lecture room of the professors (the same room serving most, or all of them) is a very indifferent one.

Griscom called on Dr. Marcet and his wife whom he saw later in London, and at their house met "Professor Prevost and de Candolle, who had been amusing themselves in sending up a paper balloon which rose to a great height and then took fire." One morning he attended an eight o'clock lecture by de Candolle, the botanist. "His style was clear and manly and his enunciation so distinct that I scarcely lost a word." Of Professor Prevost he remarks;

I had a pleasant conversation with him prior to his lecture, which I attended. He has the department of Moral Philosophy in the college, but to help out the dryness of his subject, which is concerned only with the inward light, he unites optics with it and lectures once a week on the light of the sun.

From Geneva, Griscom made a rapid tour covering Milan, Genoa, and Pavia. Here the absence of the "emeritus Volta" and the untimely death of Brugnatelli (1750–1818) kept him from contact with chemical subjects. Griscom was shown about the museums and cabinet of natural philosophy by the vice-president Configliachi "who remarked on taking us into the room for examinations, '*Voilà où on forge les docteurs.*' "

Returning to Paris for a month, Griscom then made his way to Holland.

All good lovers of Robert Louis Stevenson will remember that over the long road from Rotterdam to Leyden journeyed afoot David Balfour of Shows and the charming and unexpected Catriona. Griscom saw as did they the gardens adorned with trees, trimmed and well kept, with pleasant alleys and shady arbors; and the University so memorable in science which for four centuries has stood near the slow-moving waters of the Rhine.

The professorships of natural history (including botany, zoölogy, and mineralogy) and chemistry are concentrated in Dr. Brugmans. He conducted me to his laboratory, where I had the pleasure of seeing the furnaces, alembics, and other instruments of the great Boerhaave (1668–1738), and of standing on the very spot whence he delivered his learned instructions to audiences assembled from almost every portion of the civilized globe. The lecture room is not large but is kept in good order.

The cabinet of Natural Philosophy was shown me by Prof. Van Der Eyk, who is at the head of that course of instruction. Neither the lecture room, nor the apparatus, appears to have undergone much alteration, since the days of S'Gravesand and Muschenbroech, whose useful career of science gave a distinguished elevation to this department of the Leyden University. The air pump used by the latter is still in good order. It is gratifying to see the name of Franklin conspicuous among the electrical apparatus, in the very place where the *bottle* (Leyden jar) was discovered, which under the inspiration of his genius gave such an extension to this branch of knowledge.

Griscom crossed the channel to Harwich, visiting, on his way to London, the University of Cambridge. As a response to his letters of introduction,

We had the pleasure of breakfasting with our clerical friend T— of Peters College, in the identical room which had been occupied by the Poet Gray. The apartments are very genteel and comfortable.

At 12 we called by previous invitation on Professor Cumming at his rooms in Trinity College.[10] His accommodations are also spacious and well furnished with books and various other scientific ornaments.

Professor Cumming conducted me to his lecture room and laboratory, and showed me his apparatus. The collection appeared to be extensive and interesting, but, as might be expected during the time of vacation, it was in some confusion. In the same

[10] JAMES CUMMING (1777–1862) was professor of chemistry, though his few investigations were in physics.

building E. D. Clarke,[11] the celebrated traveller, who is professor of mineralogy in this university, has his collection and delivers his lectures. Being informed of our intended visit at the laboratory, he agreed to meet us, though suffering from a recent indisposition. Having previously ordered a fire in his lecture room, he joined us at the appointed time, and exhibited to our particular notice all that was most interesting in his curious and valuable cabinet of minerals; and also his mode of experimenting with the compound blowpipe, the results of which have gained for him a considerable share of popular scientific reputation. He was anxious to clear himself from the imputation of unfairness in neglecting to attribute the original invention of this instrument to its rightful claimant, Professor Hare of Philadelphia; and took pains to convince me that he had never deviated from candour and justice in what he had published respecting it. My impression is, that he has not been fully aware of Professor Hare's claims, nor of the results that have been obtained in America. Dr. Clarke's style of conversation and action is unusually vivid and energetic. He appears to be by nature an enthusiast; but the ardour of his fancy is tempered by learning, extensive knowledge, and the love of order.

Griscom made a more thorough examination of Cambridge than he did of Oxford and notes,

The examinations for degrees in this University (Cambridge) are almost altogether in mathematics and natural philosophy and in some colleges in the easy classics. At Oxford the examinations are chiefly in the classics. . . . . It would be an interesting subject of inquiry, to ascertain with as much accuracy as possible, the relative morality of Oxford and Cambridge; in the former, the collegiate studies are directed with paramount assiduity to moral philosophy and the higher range of classical learning, while in Cambridge mathematics and natural philosophy have a transcendent influence.

He is inclined to assign to the latter the "higher degree of moral respectability," but admits it may be due "to the superior discipline and government enforced."

At Edinburgh Griscom had a very happy time, though he had difficulty in understanding the "brogue" of the lower classes. One morning he breakfasted with Mrs. Grant "who holds a most respectable rank in the Literary Society of this place and is much visited by strangers." Here he met the brilliant and scholarly young Mr. George Tichnor of Boston.

He heard many lectures ranging from chemistry to medicine and moral philosophy and spent many hours conversing with the intellectuals of the Scottish town.

He dined with Thomas Charles Hope (1766–1844) who is famed as the discoverer of strontium (1793).

Dr. Hope was the first in Great Britain who taught the reformed chemistry. He was in Paris 30 years ago and dined as I did with Berthollet. He is a bachelor.

At ten, I went to the college, and was admitted into Dr. Hope's room, and heard him lecture to his large class on chemistry. On presenting to him, after the lecture,

[11] E. D. CLARKE (1769–1822) was an inventor of the oxy-hydrogen blowpipe (1817) at a date later than its discovery by Hare. In consequence a spirited controversy arose over the question of priority.

a letter from my valued friend, Professor Silliman, he received me politely, and offered his services in a very obliging manner. His room, as well as other parts of the university buildings, do not, in appearance, correspond with the high reputation of this school.

Dr. Hope's new lecture room will afford superior advantages to his class, already more numerous than any other in the University, and indeed larger than any class I saw on the continent. His style of lecturing is remarkably free from any strained attempt at wit or ornament; but his enunciation is full, distinct, and intelligible; he says nothing more than what it is important that he should say; but he says enough to render his subject perspicuous to his auditors. His superiority principally consists in the dexterity of his manipulations, and the uniform elegance and success of his experiments. To this part of the subject, he pays the greatest attention, sparing neither time nor expense in his preparations. Indeed, with all the well-devised apparatus, and the example of his eminent predecessor, Dr. Black, and the facility with which any additional instrument can be procured in this city, it might be expected that the professor of chemistry in this university would feel an ambition to excell in the excellence of his course of instruction. It is Dr. Hope's merit that he does feel this ambition, and hence his efforts are attended with complete success. Whatever may be alleged with respect to his want of genius, he has enough to give his subject a full and masterly elucidation, enough to satisfy all the reasonable desires of his class; and more than this, however it might extend his reputation as a philosopher, would, in all probability, tend to diminish his qualifications as a teacher. Wherever Dr. Hope has chosen to enter the field of research and investigation, he has shown himself not deficient in the power of discrimination, or the sagacity which leads to useful discovery.

THOMAS HOPE

I spent the evening with Dr. John Murray, and have several times heard him in his lecture room. This eminent chemist has been for several years in such bad health, as seldom to venture out of doors. He passes by a covered way from his chamber to his lecture room, and spends no more time in his laboratory than is absolutely unavoidable depending chiefly upon his assistants for the requisite preparations. Dr. Murray's lectures and publications have contributed very considerably to the scientific eminence of the city. Notwithstanding the popularity of the collegiate course of chemistry, he has always been attended by a respectable class; and few men, who have ever filled a chemical chair, have exceeded him in the perspicuity of his views, and the acuteness with which he examines the prevailing theories of the science.

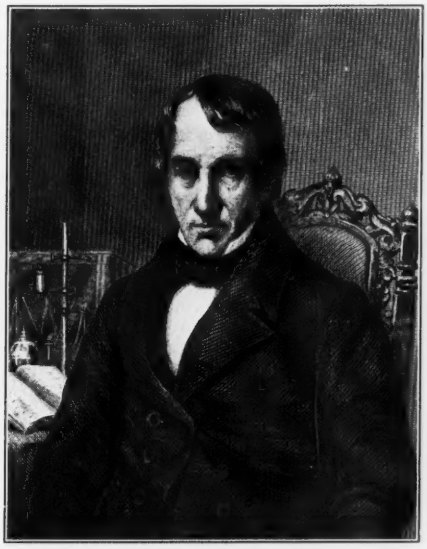
John Murray (1778–1822), who wrote a ponderous textbook on chemistry in four volumes, was one of the last defenders of the idea that chlorine was a compound of oxygen.

At Glasgow, Griscom "attended a lecture of Dr. Thomson, so well known to chemists as an author and editor. He is professor of chemistry

in this university. His lecture was upon rocks, very clear and intelligible." Thomas Thomson was the earliest and foremost advocate of Dalton's atomic theory. He gave it great publicity and did much experimental work in its behalf. An American edition of his excellent textbook, edited by Thomas Cooper, appeared in Philadelphia in 1818. Thomson's "History of Chemistry" is a remarkable piece of work.

Shortly before his return to America Griscom visited a group of "Friends" in Manchester and again met the "philosopher Dalton."

It was at once amusing and instructive to observe the simplicity and composure with which he listened to my information relative to the many inquiries and remarks respecting him which were made by some of the most distinguished philosophers of Paris, Geneva, Milan, etc. The integrity and simplicity of his character are as remarkable as the originality of his mind, and the acuteness of his perceptions on subjects of science and philosophy.



THOMAS THOMSON

During his last days in England, Griscom traversed the Lake Country, where he met the poet Wordsworth and Southey, his only touch during his year abroad with this field of letters.

The good ship Albion returned him to his native land in June, 1819. Three decades of service were left for our gentle friend in the cause of chemistry and all good works, before his death in 1852; service which was evidently appreciated by his contemporaries.

For thirty years Dr. Griscom was the acknowledged head of all other teachers of chemistry among us and its great expositor.[12]

It deserves to be stated that this conscientious professor kept pace with the flood of light which Davy, Murray, Gay Lussac, and Thénard and others shed on the progress of chemical philosophy at that day, and that the vexed questions on chlorine, the compound nature of muriatic acid, the Bakerian lectures, and the many other novelties which the new nomenclature of the time introduced, received from Dr. Griscom that attention which he pledged to his students and his honest purposes through life imposed on his labors. . . . . Dr. Griscom often reminded me of John Dalton, the founder of

[12] From an introductory discourse by John F. Francis at the opening of Bellevue Hospital in 1838.

the atomic theory. If to Dalton is justly due the high merit of discovery and elucidation, we are not to overlook the Herculean labors which Griscom performed to advance the great study among American youth. He fully perceived its great importance to the arts, to medicine and to the great business of life.[13]

. . . . . .

The following data concerning the men mentioned by Griscom in his writings may be of interest.

Name	*Born*	*Age 1818*	*Died*
Griscom, John	*1774*	*44*	*1852*
ADET	1763	55	1832
ARAGO	1786	32	1853
BANKS, JOS.	1743	75	1820
BERTHOLLET	1748	70	1822
BERZELIUS	1779	39	1848
BIOT	1774	44	1862
BRANDE	1788	30	1866
BRONGNIART	1770	48	1847
CHAPTAL	1756	62	1832
CHARLES	1746	72	1823
CLARKE, E. D.	1769	49	1822
CUMMINGS	1777	41	1861
CUVIER	1769	49	1832
DALTON	1766	52	1844
DAVY	1778	40	1829
FOURCROY	1755	63	1809
GAY-LUSSAC	1778	40	1850
HATCHETT	1765	53	1847
HENRY, WM.	1774	44	1836
HOPE	1766	52	1844
HUMBOLDT, VON	1769	49	1859
MARCET, DR.	1770	48	1822
MARCET, MRS.	1769	49	1858
MURRAY	1778	40	1820
ORFILA	1787	31	1853
PICTET	1752	66	1825
THÉNARD	1777	41	1857
THOMSON, T.	1773	45	1852
VAUQUELIN	1763	55	1829
WATT	1736	82	1819
WOLLASTON	1776	52	1828

[13] From an obituary in 1852.

Hot Spot. The highest temperature ever produced on earth, estimated at 900,000° has been roughly measured by R. Tauberg of the Westinghouse Electric and Manufacturing Company's research laboratories. This was found on a small spot on the crater of the metallic electrodes between which an electric arc was maintained inside a special type of vacuum tube. Previously the hottest known spot was on the crater of an ordinary arc light which reached 10,000°.—*Tech. Review*

RECENT PROGRESS IN THE FIELD OF SYNTHETIC PERFUMES*

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The rapid development of synthetic perfumes and the present trends are reviewed briefly, under the following headings: A. Hydrocarbons, B. Alcohols, C. Ethers, D. Aldehydes, E. Ketones, F. Acids, Esters, and Lactones, G. Castor-Oil Products, H. Nitrogen Derivatives. Among the outstanding accomplishments discussed are the determination of the constitutions of farnesol, nerolidol, the reduction of unsaturated aldehydes to the corresponding unsaturated alcohols, the introduction of hydroxycitronellal, of α-amylcinnamic aldehyde, and of ethyl vanillin, new methods for the manufacture of vanillin and ethyl vanillin, the brilliant work of Ruzicka, Kerschbaum, and others in determining the nature of the musk-scented constituents of musk, civet, ambrette seed, and angelica, and in reproducing them and analogous compounds synthetically, the proof of the structure of the lichenol of oak moss, and an outline of the many interesting products obtainable from castor oil, including the heptine carbonates and their homologs, undecalactone ("peach aldehyde"), nonanal, methyl hexyl ketone, pelargonic acid, etc.

. . . . . .

Progress in the field of synthetic perfumes has been rapid within recent years and is continuing with increasing velocity, as more and more research chemists are attracted to this fascinating branch of organic chemistry, and as factories and dealers multiply in response to the steadily growing demand for perfume products.

Not only new compounds of agreeable fragrance have been discovered, and new methods of synthesis devised, but old perfume products have been cheapened by improved processes, important new solvents, and new fixatives have been made available, and many exceedingly interesting and valuable investigations have been published upon the connection between odor and chemical constitution in selected groups or classes of compounds.

Without tarrying to mention the many new synthetics introduced as solvents or fixatives, or to review the researches upon odor and structure, we shall proceed at once to a consideration of some of the synthetic perfumes themselves, noting not only the new ones, but also the novel or improved methods introduced for the synthesis or manufacture of old ones, and the scientific investigations by which constitutional formulas have been established.

For convenience of discussion, we will group our compounds as follows:

A. Hydrocarbons
B. Alcohols
C. Ethers
D. Aldehydes
E. Ketones
F. Acids, Esters, and Lactones
G. Castor-Oil Products
H. Nitrogen Derivatives

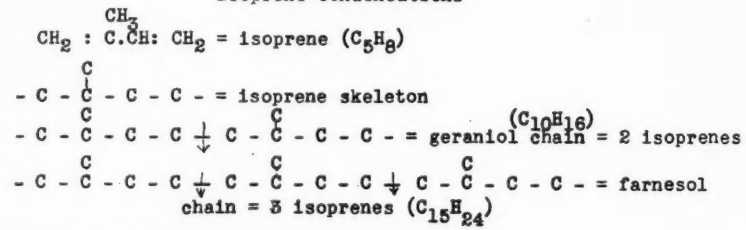
* Lecture on the A. R. L. Dohme Foundation, The Johns Hopkins University, January 16, 1931.

A. Hydrocarbons

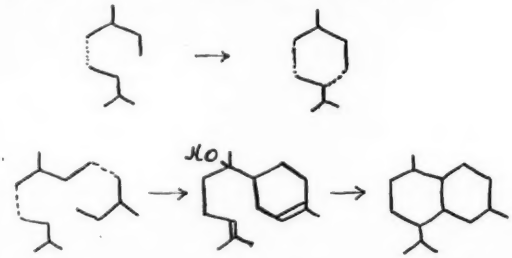
Paraffins.—*n*-Heptane, C_7H_{16}, occurs in the essential oil of the needles of *Pinus sabiniana*, and elsewhere in the vegetable kingdom.

Solid paraffins are found not infrequently in plants, but are not usually sufficiently volatile to be carried over by steam and hence may not appear in essential oils prepared in this way. Where they do occur in such oils, as, for example, in the otto of roses, they have been known under the name of "stearoptenes." When flowers, plants, etc., are extracted with vola-

Isoprene Condensations


CH2 : C.CH: CH2 = isoprene (C5H8)
- C - C - C - C - = isoprene skeleton
(C10H16)
- C - C - C - C - C - C - C - C - = geraniol chain = 2 isoprenes
- C - C - C - C - C - C - C - C - C - C - C - C - = farnesol
chain = 3 isoprenes (C15H24)

Terpenes cyclize to benzene ring.
Sesquiterpenes cyclize to naphthalene ring.
Diterpenes cyclize to phenanthrene ring.



(farnesene) (α-bisabolol) (cadaline)

tile solvents, these higher hydrocarbons are more often encountered. In most cases they appear to be mixtures, but few of whose components have been identified as yet.

The isolation of *n*-pentadecane, $C_{15}H_{32}$, by Van Romburgh (*1*) from the essential oil of the rhizomes of *Kaempferia galanga*, L., is noteworthy, because of the occurrence of derivatives of C_{15}, C_{16}, and C_{17}, in such natural products as civetone, muskone, ambrettolide, and angelica lactone.

Unsaturated Acyclic Hydrocarbons.—Octylene, C_8H_{16}, which has been reported in bergamot and in lemon oils, remains the only representative of the acyclic C_nH_{2n} series so far identified in essential oils.

Of the acyclic terpenes, $C_{10}H_{16}$, myrcene, and ocimene have been isolated from several plant oils. In other oils, similar terpenes have been found but not identified.

Aromatic Hydrocarbons.—In addition to *p*-cymene and styrene, but few naturally occurring hydrocarbons fall outside of the cyclic terpene group, and even *p*-cymene itself may be regarded as a menthatriene.

Naphthalene has been found in a few essential oils and an unidentified $C_{13}H_{10}$ has been separated from the needle oil of the *Sequoia gigantea*.

On the synthetic side, diphenylmethane is still used in soaps, because of its geranium-type of odor and its great stability.

Cyclic Terpenes.—The constitution of many important compounds in this group and their inter-relationships have been illuminated by the brilliant work of many chemists—of Ruzicka (*2*) in particular.

B. Alcohols

The alcohols of chief interest to the perfume industry today include the following: ethyl alcohol series (lower homologs as solvents, C_7 to C_{12} as perfumes), citronellol, geraniol and nerol, linalöol, methylheptenol, farnesol and dihydrofarnesol, nerolidol, and dihydronerolidol, benzyl, phenylethyl, phenylpropyl, cumic (cuminic), benzyl alkyl carbinols, benzyl phenyl carbinols, cinnamyl, styrolene, cyclogeraniol, terpineols, isopulegol, santalol, cedrol, and vetiverol (vetivenol).

Higher Acyclic Alcohols.—The C_8 to C_{12} members of the ethyl alcohol series have strong odors somewhat resembling a rose type, and when used in small proportions have proved valuable additions to perfume blends. Like their corresponding aldehydes, many of them have been known for years, but it is only recently that they have found favor with the perfumer.

The organic laboratories of Johns Hopkins have rendered very valuable service in the alcohol field by showing how crystalline esters of sharp melting point may be prepared from them for purposes of identification, and by such researches as the recent one covering twenty-three isomeric octyl alcohols.

n-Octyl Alcohol (*n*-capryl alcohol), $C_7H_{15}CH_2OH$, is prepared by converting caprylic acid, from cocoanut oil, into its ester, and reducing the latter by sodium and alcohol.

Secondary Octyl Alcohol (secondary capryl alcohol), $C_6H_{13}CH(OH)CH_3$, from castor oil has a stronger odor than the normal isomer.

n-Nonyl Alcohol, $C_8H_{17}CH_2OH$. Undecylenic acid, from castor oil, when fused with KOH, gives pelargonic (nonylic or nonoic) acid, reduction of whose ester gives the alcohol desired.

n-Decyl Alcohol, $C_9H_{19}CH_2OH$, can be prepared by reduction of the corresponding aldehyde, or of decylic ester.

Alcohols

$C_{10}H_{18}O$ $Me_2C{:}CH.CH_2.CH_2.\underset{\displaystyle OH}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{C}}}}.CH{:}CH_2$ = Linalool

$C_{10}H_{18}O$ $Me_2C{:}CH.CH_2.CH_2.\underset{\displaystyle HC.CH_2OH}{\overset{\displaystyle CH_3}{\underset{\|}{\overset{|}{C}}}}$ = Geraniol

$C_{10}H_{18}O$ $Me_2C{:}CH.CH_2.CH_2.\underset{\displaystyle HOCH_2.CH}{\overset{\displaystyle CH_3}{\underset{\|}{\overset{|}{C}}}}$ = Nerol

$C_{10}H_{20}O$ $Me_2C{:}CH.CH_2.CH_2.\overset{\displaystyle CH_3}{\overset{|}{C}}H.CH_2.CH_2OH$ Citronellol, Terpinolene form, Barber's rhodinol

$\overset{\displaystyle Me}{\overset{\displaystyle CH_2}{\diagdown\!\!=\!\!\diagup}}C.CH_2.CH_2.CH_2.\overset{\displaystyle CH_3}{\overset{|}{C}}H.CH_2.CH_2OH$ (-HX, +HX) Citronellol, Limonene form

3-Methyl-Nonyl Alcohol, $C_6H_{13}CH(CH_3)CH_2CH_2OH$.—Its synthesis is described later under the corresponding aldehyde.

n-Hendecyl Alcohol (*n*-undecyl alcohol), $C_{10}H_{21}CH_2OH$, can be manufactured by reducing its aldehyde with zinc and acetic acid.

n-Dodecyl Alcohol (lauryl alcohol), $C_{11}H_{23}CH_2OH$.—Its synthesis also is described under the corresponding aldehyde.

Other interesting saturated acyclic C_{10} alcohols which have become

Aldehydes

$C_{10}H_{16}O$ $Me_2C{:}CH.CH_2CH_2.\underset{\displaystyle HC.CHO}{\overset{\displaystyle CH_3}{\underset{\|}{\overset{|}{C}}}}$ = Citral a (Geranial)

$C_{10}H_{16}O$ $Me_2C{:}CH.CH_2.CH_2.\underset{\displaystyle HOC.CH}{\overset{\displaystyle CH_3}{\underset{\|}{\overset{|}{C}}}}$ - Citral b (Neral)

$C_{10}H_{18}O$ $Me_2C{:}CH.CH_2.CH_2.\overset{\displaystyle CH_3}{\overset{|}{C}}H.CH_2.CHO$ = Terpinolene form (Rhodinal)

$\overset{\displaystyle Me}{\overset{\displaystyle CH_2}{\diagdown\!\!=\!\!\diagup}}C.CH_2.CH_2.CH_2.\overset{\displaystyle CH_3}{\overset{|}{C}}H.CH_2CHO$ = Limonene form (True Citronellal)

Sesquiterpene (C_{15}) Acyclic Alcohols

(R = $Me_2C{:}CH.CH_2.CH_2-$)

(1) $R.C(Me){:}CH\ CH_2CH_2C(Me){:}CH.CH_2OH$ = farnesol.

(2) $R.C(Me){:}CH\ CH_2CH_2CH(Me)CH_2CH_2OH$ = dihydrofarnesol of Kerschbaum and Verley.

(3) $R.CH(Me)\ CH_2CH_2CH_2C(Me){:}\ CH.CH_2OH$ = dihydrofarnesol of Ruzicka.

(4) $R.C(Me){:}CHCH_2CH_2C(Me)(OH)CH{:}CH_2$ = nerolidol.

(5) $R.CH(Me)CH_2CH_2CH_2C(Me)(OH)CH{:}CH_2$ = dihydro-nerolidol.

(6) One of unknown structure in gum ammoniac (Semmler, Jonas and Rönisch; Ber., 50, 1823 (1917)).
Structures given above depend upon structures assigned to geraniol and geranial (citral).

available recently are the tetrahydrolinalöol and the tetrahydrogeraniol (dihydro citronellol).

Hydroxycitronellol.—The statement has been made by Durrans (*3*) that this is likely to be available soon for the perfume industry.

Farnesol.—This acyclic sesquiterpene alcohol was discovered in the essential oil of *Acacia farnesiana* (cassie) (*4*) and gets its name from this origin. It occurs in a number of other volatile plant oils, but is most conveniently recovered from the oil of ambrette seed, although present there only to the extent of 0.12%. Its production from natural sources was patented also by Haarmann and Reimer (*5*). It is valuable both on account of its fine floral odor in dilute solution and because of its fixative properties when used in perfume blends.

Its constitution was determined by the work especially of Kerschbaum (*6*), Harries and Haarmann (*7*), Ruzicka (*8*), and Verley (*9*).

Its constitution was deduced by a consideration of the following facts:

Molecular formula, $C_{15}H_{26}O$.

Molecular refraction, addition of 6H or 6Br, and formation of a triozonide in chloroform, show three ethylene bonds.

Oxidizes to an aldehyde (farnesal) of same carbon content, forms an acetate and an acid phthalate. Hence a primary acyclic alcohol.

Farnesal reduces to farnesol.

Farnesal oxime + Ac_2O = farnesic nitrile, which can be hydrolyzed first to farnesic acid, which then yields dihydropseudoionone and acetic acid.

Geranic nitrile similarly yields geranic acid, methylheptenone, and AcOH.

Verley (*9*) showed that farnesal + K_2CO_3 solution = dihydropseudoionone + acetaldehyde, just as

Citral (geranial) + K_2CO_3 solution = methylheptenone and acetaldehyde.

Hence it is probable that farnesol contains the terminal group —CMe:CH.CH_2OH, and bears the same relation to dihydropseudoionone that geraniol does to methylheptenone. The structure of farnesol therefore depends upon the constitution assigned to geraniol and geranial (citral).

Farnesol (1)

$Me_2C:CHCH_2CH_2C(Me):CHCHO$ = citral (geranial)

$Me_2C:CHCH_2CH_2C(Me):CH.CN$ = geranic nitrile

$Me_2C:CHCH_2CH_2C(Me):CH.COOH$ = geranic acid

$Me_2C:CHCH_2CH_2COMe$ (Me heptenone) + CH_3COOH

$Me_2C:CHCH_2CH_2C(Me):CHCH_2CH_2C(Me):CHCHO$ = farnesal

$Me_2C:CHCH_2CH_2C(Me):CHCH_2CH_2C(Me):CHCN$ = farnesic nitrile

$Me_2C:CHCH_2CH_2C(Me):CHCH_2CH_2C(Me):CH.COOH$ = farnesic acid

$Me_2C:CHCH_2CH_2C(Me):CHCH_2CH_2COMe$ + CH_3COOH
(dihydro-pseudoionone)

Hence farnesol probably contains a terminal $-C(Me):CHCH_2OH$ group and bears same relation to dihydro-pseudoionone that geraniol does to Me heptenone.

The structure of methylheptenone and of dihydropseudoionone follows from their reactions and their synthesis.

By addition at low temperature of a glacial acetic acid solution of hydrogen bromide to isoprene, the amylene bromide required is formed. When the latter is condensed with sodium acetoacetate and the product hydrolyzed, methylheptenone results.

Farnesol (2)

$CH_2:CMeCH:CH_2$ + 2HBr + AcOH →

$Me_2CBr.CH_2CH_2Br$, + $NaCH(COOR)COCH_3$ + RONa →

$Me_2C:CHCH_2CH(COOR)COCH_3$, + hydrol →

$Me_2C:CH(CH_2)_2.COCH_3$ (methyl heptenone).

$Me_2C:CH(CH_2)_2.CMe:CHCHO$ (citral) + CH_3COCH_3 →

" $.CMe:CHCH:CHCOCH_3$ ①, + catalytic reduction →

" $.CMe:CH(CH_2)_2COCH_3$ (dihydro ps-ionone).

" $.CMe:CHCH_2Cl$ ② + $NaCH(COOR)Ac$ →

" $.CMe:CHCH_2CH(COOR)Ac$ + hydrol

① = pseudoionone ② = geranyl chloride.

Pseudoionone is formed by the condensation of citral with acetone. The structure of the dihydropseudoionone obtained by the hydrolysis of farnesic acid was proved by Dupont and Labaune (*10*), who synthesized it from geranyl chloride and sodium acetoacetate, with subsequent saponification. Verley also prepared the same dihydropseudoionone by the catalytic hydrogenation of ionone.

Kerschbaum condensed this dihydropseudoionone (I) with bromomagnesium acetic ester, hydrolyzed the product to the hydroxydihydrofarnesic ester (II), which gave methyl farnesate (III) when treated with acetic anhydride. Reduction of this ester by the Bouveault-Blanc method gave mainly dihydrofarnesol (V), with only a small yield of farnesol (IV), just as geranic ester (VI), under similar conditions, gives mainly citronellol (VIII) with but little geraniol (VII). In both cases, the α-β unsaturation hydrogenates about as rapidly as the ester reduces to the alcohol.

Farnesol (3)

(I) $Me_2C{:}CH(CH_2)_2CMe{:}CH(CH_2)_2COCH_3$ + $BrMgCH_2COOR$ →

(II) " $:CH(CH_2)_2CMe(OH)CH_2COOR$, + Ac_2O →

(III) " $:CH(CH_2)_2CMe{:}CHCOOR$, + Na + alc →

(IV) " $:CH(CH_2)_2CMe{:}CHCH_2OH$ (small amount) +

(V) " $:CH(CH_2)_2CHMeCH_2CH_2OH$ (mainly)

(VI) $Me_2C{:}CH(CH_2)_2CMe{:}CH\ COOR$ + Na + alc →

(VII) $Me_2C{:}CH(CH_2)_2CMe{:}CHCH_2OH$ (small amt) +

(VIII) $Me_2C{:}CH(CH_2)_2CHMe.CH_2CH_2OH$ (mainly).

(I) = dihydro pseudoionone → (II) = hydroxy dihydrofarnesate
(III) = farnesate → (IV) = farnesol → (V) = dihydrofarnesol.
(VI) = geranate → (VII) = geraniol → (VIII) = citronellol.

Verley (*9*) synthesized dihydrofarnesol (V) as follows: dihydropseudoionone (I) was condensed with bromacetic ester and the product hydrolyzed as before to the hydroxydihydrofarnesate (II), and the glycidic ester (IX). Reduction of the latter with sodium and amyl alcohol gave dihydro-

Farnesol (4)

(I) $Me_2C{:}CH(CH_2)_2CMe{:}CH(CH_2)_2COCH_3$ + $BrCH_2COOR$ →

(II) " $:CH(CH_2)_2CMe(OH)CH_2COOR$ →

(IX) " $:CH(CH_2)_2C\overset{O}{\diagdown\diagup}CHCOOR$, + reduction →

(V) " $:CH(CH_2)_2CHMeCH_2CH_2OH$

(I) = dihydro pseudoionone → (II) = hydroxy dihydrofarnesate.

(IX) = glycidic ester → (V) = dihydrofarnesol.

farnesol (V) direct. He described its odor as like that of farnesol, of a very delicate cedar-wood type when in pure state and of very floral odor when in high dilution. It is now on the market.

Farnesol is most conveniently prepared from the isomeric nerolidol, as described in the discussion of the latter alcohol.

Nerolidol.—This isomer of farnesol takes its name from its discovery by Hesse and Zeitschel (*11*) in oil neroli. It was really isolated first in an impure condition by Thoms (*12*) from Peru balsam by saponification. He called it "Peruviol," and assigned the formula $C_{13}H_{22}O$. It was later shown in the Schimmel Laboratories (*13*) that when pure the formula of this "Peruviol" was $C_{15}H_{26}O$, and that it was identical with nerolidol, since both gave the same phenylurethane (m. p., 37–38°C.).

Its constitution was arrived at by a consideration of the following data:

Molecular formula, $C_{15}H_{26}O$.

Molecular refraction indicates 3 ethylene bonds.

It forms urethanes and esters only with great difficulty, and is therefore probably a tertiary alcohol.

Nerolidol + Ac_2O = farnesene and farnesyl acetate.

Linalöol + Ac_2O = Myrcene and geranyl acetate.

Oxidized with CrO_3 and AcOH = farnesal. Hence the carbon skeleton of nerolidol and farnesol is probably the same.

Linalöol oxidizes similarly to citral.

Nerolidol (1)

(I) $Me_2C{:}CH(CH_2)_2.CMe(OH)CH{:}CH_2 + Ac_2O \rightarrow$

(II) " $.CMe{:}CHCH_2OH$ (acetate) and

(III) " $.C(:CH_2)CH{:}CH_2$

(IV) " $.CMe{:}CH(CH_2)_2.CMe(OH)CH{:}CH_2 + Ac_2O \rightarrow$

(V) " . " $.CMe{:}CHCH_2OH$ (acetate) and

(VI) " $.CMe{:}CHCH_2CH{:}CMe.CH{:}CH_2$ (?)

(I) = linalool → (II) = geraniol and (III) = myrcene.

(IV) = nerolidol → (V) = farnesol and (VI) = farnesene.

Nerolidol = linalool + 1 mol isoprene.

Farnesol = geraniol + " " " .

Nerolidol may therefore be regarded as derived from linalöol by addition of a molecule of isoprene, as farnesol from geraniol.

Ruzicka and Fornasir (*14*) succeeded in converting methyl heptenone (IX) into dehydrolinalool (X) by application of the Nef reaction (*15*), that is, by passing acetylene into an absolute ether solution of the ketone

Nerolidol (2)

(I) $Me_2C{:}CH(CH_2)_2.CMe(OH)CH{:}CH_2 + CrO_3 + AcOH \rightarrow$

(VII) " .CMe:CH.CHO

(IV) " .CMe:CH$(CH_2)_2$.CMe(OH)CH:$CH_2 + CrO_3 + AcOH \rightarrow$

(VIII) " . " .CMe:CH.CHO

(I) = linalool → (VII) = citral (geranial)

(IV) = nerolidol → (VIII) = farnesal.

in the presence of sodamide at temperatures below 0°C. Reduction of this dihydro compound in moist ether solution by sodium, gave linalöol (I).

Ruzicka (*16*) then applied the same series of reactions to the synthesis of inactive nerolidol (IV) from dihydropseudoionone (XI), and of inactive dihydronerolidol (XVI) from tetrahydropseudoionone (XIV) (prepared by the catalytic reduction of pseudoionone).

Nerolidol (3)

(IX) $Me_2C{:}CH(CH_2)_2.COCH_3 + C_2H_2 + NaNH_2 \rightarrow$

(X) " .CMe(OH)C:CH, + Na + moist ether →

(I) " .CMe(OH)CH:CH_2

(XI) " .CMe:CH$(CH_2)_2$.$COCH_3 + C_2H_2 + NaNH_2 \rightarrow$

(XII) " . " .CMe(OH)C:CH, + redn →

(IV) " . " .CMe(OH)CH:CH_2

(IX) = methyl heptenone → (X) = dehydro-linalool →

(I) = linalool. - So, (XI) = dihydro-pseudoionone →

(XII) = dehydro-nerolidol → (XIII) = inactive nerolidol.

Nerolidol (4)

(XIII) $Me_2C{:}CH(CH_2)_2.CMe{:}CH.CH{:}CHCOCH_3$, + cat.redn →

(XIV) " .CHMe$(CH_2)_3.COCH_3$, + $C_2H_2 + NaNH_2$ →

(XV) " . " .CMe(OH)C:CH, + redn →

(XVI) " . " .CMe(OH)CH:CH_2

(XIII) = pseudoionone → (XIV) = tetrahydro pseudoioncne →

(XV) = dehydro dihydronerolidol → (XVI) = i-dihydro nerolidol.

Farnesol is now produced from the isomeric nerolidol (*17*) by two different processes:

(1) Nerolidol is heated with acetic anhydride in an atmosphere of CO_2, which gives a mixture of farnesyl acetate and some nerolidyl acetate. The mixed esters are saponified and treated with phthalic anhydride, which esterifies farnesol but not nerolidol. Farnesyl acid phthalate is then saponified.

(2) Oxidation of nerolidol with chromic acid mixture gives farnesal, which can be reduced to farnesol by sodium amalgam. Of these two processes, the former is the better.

As already noted, nerolidol may be converted into farnesyl acetate by the action of acetic anhydride, from which farnesol can be obtained. The same reaction applied to dihydronerolidol gives a dihydrofarnesol isomeric with that prepared by Kerschbaum and by Verley, but which possesses an odor very similar to that of farnesol itself.

Both farnesol and nerolidol may exist in stereoisomeric forms. Farnesal has no asymmetric carbon, but two olefin bonds each of which can give *cis* and *trans* forms, so that there exists the possibility of four stereoisomeric farnesols, all inactive.

Of the three double bonds in nerolidol, two are of such character as to be unable to create such isomers. One is the $:CH_2$, and the other is either an $Me_2C:$ or $CH_3C:CH_2$ group. The remaining double bond should permit *cis*, *trans* isomers. The carbon carrying the hydroxyl, further, is asymmetric. Both *cis* and *trans* forms, therefore, can exist in *d*-, *l*-, and *i*-configuration.

Following up the interesting work in which he has been occupied for a number of years, von Braun has shown that just as the odor of *iso*-nonyl aldehyde is superior to that of *n*-nonyl aldehyde, so that of the branched-chain *n*-hexahydrofarnesal is preferable to the aroma of the isomeric straight chain myristaldehyde.

Farnesol (5)

(X) $Me_2C:CH(CH_2)_2CHMe.CH_2CH_2OH$, + H + Pd →

(XI) $Me_2CH(CH_2)_3CHMe.CH_2.CH_2OH$, + HBr →

(XII) " $.CH_2.CH_2Br$, + Me_3N →

(XIII) " $.CH_2.CH_2NMe_3Br$, + Ag_2O →

(XIV) " $.CH_2.CH_2NMe_3OH$, + distn + KOH →

(XV) " $.CH_2.CH_2NMe_2$ (20%) and

(XVI) " $.CH:CH_2$ (65%), + O_3, then + H_2O + Zn dust →

(XVII) " .CHO (> 50%).

(X) = citronellol → (XI) = dihydrocitronellol
(XII) = 2,6-dimethyl octyl bromide.
(XVI) = 2,6-dimethyl-7-octene
(XVII) = 2,6-dimethyl-7-heptanal = iso-nonyl aldehyde.

The *iso*-nonyl aldehyde was synthesized by von Braun and Teuffert (*18*) from citronellol (X), which was reduced by hydrogen and palladium to its dihydro derivative (XI). By the action of hydrogen bromide, the latter gave the corresponding bromide (XII), which was combined with trimethylamine, the resultant quaternary salt (XIII) changed to the hydroxide (XIV) by moist silver oxide and this base distilled over potassium hydroxide. There resulted a mixture of the dimethyloctyldimethylamine (XV) (20% yield) and the dimethyloctene (XVI) (65% yield). When the ozonide of this octene was decomposed by water, in the presence of zinc dust, *iso*-nonyl aldehyde (XVII) was obtained (yield, over 50%). Its odor was stated to resemble that of its normal isomer but to be stronger and pleasanter.

The same series of reactions applied to hexahydrofarnesol (XVIII), gave von Braun and Anton (*19*) a mixture of hexahydrofarnesene (XXIII) (80% yield) and the hexahydrofarnesyldimethylamine (XXII) (20% yield). From the ozonide of the former, *n*-hexahydrofarnesal (XXIV) was produced, which when freshly distilled possessed an unusually pleasant, refreshing, and strong floral odor, which grew weaker as the aldehyde increased in density on standing. The isomeric straight-chain myristaldehyde (*n*-tetradecanal) has only a faint odor which, on account of its fatty quality, is not very agreeable.

Farnesol (6)

(IV) $Me_2C{:}CH(CH_2)_2CMe{:}CH(CH_2)_2CMe{:}CHCH_2OH$, + cat. redn →

(XVIII) $Me_2CH(CH_2)_3CHMe(CH_2)_3CHMe.CH_2CH_2OH$, + HBr →

(XIX) " $.CH_2CH_2Br$, + Me_3N →

(XX) " $.CH_2CH_2NMe_3Br$, + Ag_2O →

(XXI) " $.CH_2CH_2NMe_3OH$, + distn →

(XXII) " $.CH_2CH_2NMe_2$ (20%) and

(XXIII) " $.CH{:}CH_2$ (80%), + O_3 etc. →

(XXIV) " .CHO

(IV) = farnesol → (XVIII) = hexahydrofarnesol.

(XIX) = hexahydrofarnesyl bromide. (XXIII) = hexahydrofarnesene.

(XXIV) = 2,6,10-trimethylundecanal = nor-hexahydrofarnesal.

Hexahydrofarnesal itself, prepared by careful oxidation of a glacial acetic acid solution of the alcohol (XVIII) with chromic oxide, likewise had a pleasant odor, but not so refreshing or floral as that of the lower homolog noted above.

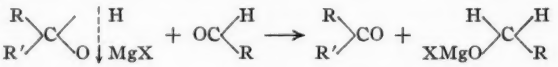
Cinnamyl Alcohol.—This alcohol, $C_6H_5CH{:}CHCH_2OH$, sometimes known as styryl alcohol, or styrone, has hitherto been obtained almost

always from storax, but the introduction of new methods of reducing unsaturated aldehydes has led to its production from cinnamic aldehyde.

The reduction of unsaturated aldehydes to the corresponding unsaturated alcohols, without saturation of the double bond, reduction to hydrocarbon, or formation of glycols, has been a problem which has confronted the organic chemist for some time, and for whose solution various methods have been suggested.

Iron and acetic acid have been used on aldehydes (*20*) or on their diacetates (*21*) but the methods are tedious and the yields unsatisfactory.

The reducing action of aliphatic Grignard reagents on aldehydes and ketones has been known for many years, Marshall's experiments (*22*) supported by the work of Meisenheimer (*23*) and of Shankland and Gomberg (*24*) make it clear that it is not the Grignard reagent itself which functions as the reducing agent in such cases, but the addition product formed by the reagent with the aldehyde, R·CH(OMgX)R′, which is then oxidized by the excess of aldehyde, the latter being compensatingly reduced:



Lüttringhaus (*25*) patented a process of reducing aldehydes to alcohols by the action of ethyl alcohol in the presence of activated magnesium, the alcohol being oxidized simultaneously to aldehyde, and claimed the successful reduction of citronellal, geranial (citral), and cinnamic aldehydes to the corresponding alcohols.

Meerwein and Schmidt (*26*) discovered that $Al(OR)_3$, or ROMgX, in the presence of some free ROH, acting on aldehydes at moderate temperatures, gave 80 to 90% yields of the corresponding alcohols, the aldehyde and alcohol groups exchanging partners, the equilibrium being kept moving to the right by the removal of the aldehydic by-product as fast as formed:

$$RCHO + R'CH_2OH \rightleftharpoons R{\cdot}CH_2OH + R'CHO.$$

Among the alcohols they secured in this way from their aldehydes, were geraniol and hydroxy citronellol.

Ponndorf (*27*) by the use of a similar method, successfully prepared cinnamic alcohol, geraniol and nerol, carveol, and other alcohols, from the corresponding aldehyde or ketone. As pointed out by Gibson and Simonsen (*28*), *dl*-piperitol can thus be prepared readily from *dl*-piperitone.

Inasmuch as a compensating oxidation and reduction seems to be involved in the change, it has been likened to the Cannizzaro reaction.

The noteworthy fact remains, however, that when $Al(OR)_3$ acts upon mixtures of aldehydes and alcohols, the products are the same as when

ROMgX is the catalyst, although aluminum does not form organic complexes of exactly the same type as magnesium.

Child and Adkins (*29*) carried out an interesting series of experiments, using aluminum ethoxide as catalyst to convert aldehydes into esters, $2RCHO \longrightarrow RCOOCH_2R$.

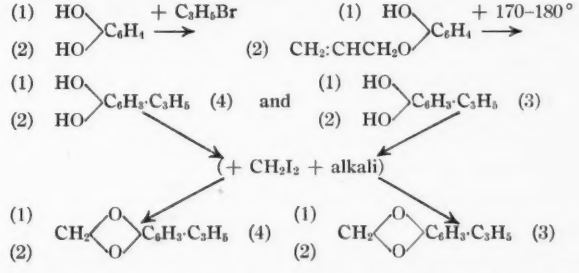
Adams and his co-workers (*30*) obtained an excellent yield of cinnamic alcohol by reducing cinnamic aldehyde with hydrogen in the presence of their platinum-oxide-platinum-black catalyst.

C. Ethers

The following ethers are used today, either on account of their perfume or fixative value: geranyl alkyl ethers, benzyl alkyl ethers, benzyl eugenyl and iso-eugenyl ethers, phenyl, *p*-cresyl, *p*-cresyl alkyl ethers, phenyl-*p*-cresyl, dimethyl hydroquinone, anethole, eugenol and iso-eugenol and their ethers, safrole and iso-safrole, phenyl dimethylacetate, eucalyptol, *β*-naphthyl alkyl ethers.

Diphenyl Ether.—This very stable compound has been used for many years, particularly in soaps, on account of its agreeable geranium type of odor, but it remained for the late Dr. H. A. Dow to point out that it was so stable to high temperatures that it could be used in place of mercury (being non-toxic and cheaper) in bi-fluid heating systems, the diphenyl ether itself being vaporized in the first boiler by direct heat, and the exhaust from this still being at such a high temperature that it could convert water into steam in the second boiler. As suggested by the late Dr. Slosson, we might thus have geranium-scented boiler rooms.

Safrole.—Perkin and Trikojus (*31*) carried out the following interesting synthesis of this important material:



It is worth noting that these investigators found the odor of *o*-safrole to be much like that of safrole itself.

D. Aldehydes

Among those in use today, the following should be mentioned: higher saturated acyclic aldehydes (C_8 to C_{12}), citronellal, citral, hydroxycitronel-

lal, cyclocitral, cyclohydroxycitronellal, benzaldehyde, *p*-toluic, anisic, salicylic, hydrocinnamic, phenyl acetic, *p*-tolyl propionic, *p*-cymyl acetic, cinnamic and its α-butyl and α-amyl derivatives, vanillin, methyl vanillin (veratric aldehyde), ethyl vanillin, cumic (cuminic), and piperonal (heliotropin).

Saturated Acyclic Aldehydes.—Most of these aldehydes have been known for some time, but their value in perfume blends, particularly when used in very small amount, has been but lately fully understood and appreciated.

n-Heptanal (*n*-heptylic aldehyde, *n*-enanthaldehyde), $CH_3(CH_2)_5CHO$.—This is one of the products of the dry distillation of castor oil. Its odor is pungent and penetrating and has been described as of "sharp orange" type.

n-Octanal (*n*-octylic aldehyde, *n*-caprylaldehyde), $CH_3(CH_2)_6CHO$, occurs in several essential oils and is prepared synthetically by distilling the mixed calcium salts of caprylic (from cocoanut oil) and formic acids. Its odor is also orange-like, but less pungent than that of *n*-heptanal.

n-Nonanal (*n*-nonylic aldehyde, *n*-pelargonaldehyde), $CH_3(CH_2)_7CHO$, also found in various essential oils, is produced from pelargonic acid (from castor oil), which is esterified, the ester reduced to *n*-nonanol, and the latter oxidized to the aldehyde by chromic acid or by catalytic dehydrogenation. Its aroma resembles that of *n*-octanal, but is more "fatty."

n-Decanal (*n*-decylic aldehyde, *n*-capraldehyde), $CH_3(CH_2)_3CHO$, obtained similarly from decylic (capric) acid, has perhaps the most desirable odor of all these higher acyclic aldehydes, being neither too pungent nor too "fatty."

Methyl-3-nonanal-1 (beta-methyl-nonylic aldehyde), $CH_3(CH_2)_5CH(CH_3)CH_2CHO$, can be synthesized from methyl hexyl ketone.

n-Hendecanal (*n*-undecylic aldehyde), $CH_3(CH_2)_9CHO$.—Lauric acid yields lauryl chloride, which is brominated in the alpha position, the resulting bromolauryl chloride hydrolyzed and the hydroxy acid distilled:

$$CH_3(CH_2)_9CH_2COOH \longrightarrow CH_3(CH_2)_9CH_2COCl \longrightarrow$$
$$CH_3(CH_2)_9CHBrCOCl \longrightarrow CH_3(CH_2)_9CH(OH)COOH \longrightarrow$$
$$CH_3(CH_2)_9CHO + H_2O + CO.$$

Its odor resembles the next lower homolog but is rather more "fatty."

n-Dodecanal (*n*-duodecylic aldehyde, lauraldehyde), $CH_3(CH_2)_{10}CHO$.—Lauric acid, from cocoa butter, is converted into ethyl laurate, which is reduced to lauryl alcohol and the latter reoxidized to the aldehyde. Its odor is similar to that of the C_{11} aldehyde but still more "fatty."

The product generally sold as "C_{14} peach aldehyde" is really γ-undecalactone; while the so-called "C_{16} strawberry aldehyde" is actually the ethyl ester of methyl phenyl glycidic acid. Both are recorded later in their appropriate places.

Hydroxy Citronellal.—This is manufactured synthetically by the addition of the elements of water to the olefin bond of citronellal, and its structural formula hence is probably one or the other of the following:

$$Me_2C(OH)(CH_2)_3CHMe{\cdot}CH_2CHO \text{ or}$$
$$Me_2CH{\cdot}(CHOH)(CH_2)_2CHMeCH_2CHO$$

It is quite likely that the commercial product is often a mixture of the two, as happened in the early days of ionone manufacture before the *alpha* and *beta* forms were separated.

The technic involved in its successful preparation is difficult and tricky, and the details closely guarded by the manufacturers. Both the initial citronellal and its hydration product are very sensitive compounds, readily undergoing changes of various kinds (condensation, polymerization, cyclization, etc.), and are therefore troublesome to handle and purify.

The literature records the following methods, but usually without sufficient detail to enable the inexperienced to obtain a satisfactory yield of pure product:

(*a*) Solid citronellal sodium bisulfite treated with dilute sulfuric acid at low temperatures, yields a water-soluble product, from which caustic alkali liberates the hydroxy citronellal.

(*b*) Citronellal cyanohydrin, from the aldehyde and HCN, yields the desired product when distilled under reduced pressure in the presence of water.

(*c*) Citronellal and acetic anhydride, under properly controlled conditions, give a citronellal enol acetate which is then treated with dilute alkali.

In view of the fact that this product is obtained by the addition of a molecule of water to citronellal, a more accurate name for it would be either citronellal hydrate or hydroxydihydrocitronellal.

In respect of beauty of odor, availability at a moderate price, and widespread applicability in perfume blends, this new synthetic is perhaps the most valuable product added to the resources of the perfumer within the past decade. It possesses a wonderfully fresh, rich, and fine fragrance, of lily-of-the-valley type, unequaled by any other product, synthetic or isolate, now on the market.

Hydroxycitral is protected by patent (*32*), but does not seem to be available as yet for the industry.

Anisic Aldehyde, p-$CH_3OC_6H_4CHO$, hitherto prepared almost exclusively by oxidation of the anethole from oil of anise, can now be produced of satisfactory quality, and at moderate cost, by oxidation of p-cresyl methyl ether with MnO_2 and H_2SO_4. Until recently, the necessary p-cresol has been too impure and the methylating agents too expensive.

Hydrocinnamic Aldehyde (beta - phenyl - propionaldehyde), Ph - CH_2-CH_2CHO, has shown itself to be a fairly satisfactory substitute often for

the less stable phenyl acetaldehyde, although its fragrance is less pleasing and weaker. In blends of the rose, lily-of-the-valley or lilac type, it has also found favor.

Synthetically, it is prepared either by catalytic reduction of cinnamic aldehyde (Process A), or catalytic dehydrogenation of γ-phenyl-propyl alcohol, (Process B):

(A) $PhCH{:}CH{\cdot}CHO + H_2 = PhCH_2{\cdot}CH_2{\cdot}CHO$
(B) $PhCH_2CH_2CH_2OH = PhCH_2{\cdot}CH_2{\cdot}CHO + H_2$

α-n-Amyl Cinnamic Aldehyde, $PhCH{:}C(C_5H_{11})CHO$.—This newcomer has won instant and widespread recognition, particularly for use in blends of the jasmine type, where it supplies a note and freshness heretofore lacking.

It appears to have been described first by Rutovski and Korolew (*33*), and is now marketed under a host of different trade names.

It can be prepared by the usual Claisen condensation, using benzoic and *n*-heptoic aldehydes:

$$C_6H_5CH{:}O + H_2{:}C(CH_2)_4CH_3{\cdot}COH \longrightarrow C_6H_5CH{:}C(C_5H_{11}){\cdot}COH$$

Other aldehydes of this type have been developed lately, carrying different radicals in place of the amyl; and by condensing such cinnamic aldehydes with other aldehydes, new products have been obtained carrying two or more olefin bonds in the side chain, but they do not seem as yet to have won any extensive use.

Darzen's method (*34*) of preparing aldehydes through glycidic esters has often been found most helpful.

Vanillin and Ethyl Vanillin.—Hosts of patents have been taken out for the manufacture of vanillin, but the most widely used processes have remained those in which either oil of cloves or guaiacol serves as initial material.

Because of the low price of safrole from camphor oil, this phenolic ether also has been utilized recently as a source of vanillin. The process consists in heating safrole (I), or iso-safrole (II), with a 25% MeOH solution of KOH under pressure at 140–170°C., which breaks open the methylene dioxy ring and simultaneously rearranges the allyl side chain to the propenyl (or iso-allyl) structure, yielding the two isomeric 3-alkoxy methoxy-4-hydroxy (III) and 4-alkoxy methoxy-3-hydroxy (IV) propenyl benzene. The free OH groups are alkylated by methyl or ethyl sulfate, giving (V) and (VI), the alkoxy methoxy groups hydrolyzed by alcoholic HCl to the isochavibetol or iso-eugenol types (VII) and (VIII), which are then oxidized to the corresponding iso-vanillin (X) and vanillin (XI). Since neither iso-chavibetol (VII) nor iso-vanillin (X) is of any use as such to the perfumer, the iso-chavibetol is methylated to methyl iso-eugenol

(IX), and the latter subjected to the action of MeOH-KOH under pressure. A mixture of iso-eugenol and iso-chavibetol results, from which the former is separated for oxidation to vanillin and the latter is again subjected to methylation and the MeOH-KOH treatment to convert more of it into the former, the treatment being repeated as often as seems worthwhile (*35*).

Since Huon pine oil is rich in methyl eugenol (XII), it too may serve as a raw material for this process, the hot alcoholic alkali under pressure isomerizing this methyl eugenol to methyl iso-eugenol, which latter then yields a mixture of iso-eugenol and iso-chavibetol.

The Graesser-Monsanto Chemical Works and D. P. Hudson (*36*) have discovered that compound (III) can be simultaneously oxidized and hydrolyzed to the corresponding hydroxy aldehyde (XIV) (protocatechuic aldehyde), by the action of nitrobenzene and caustic alkali, whereas, under the same conditions, the isomer (IV) remains practically unchanged. In the application of this modification of the process, the mixture of (III) and (IV) is subjected to the action of nitrobenzene and caustic alkali, the protocatechuic aldehyde (XIV) and the unchanged (IV) are separated,

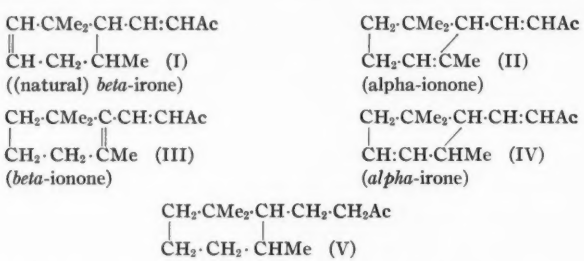
the latter being used as already described and the former being alkylated to a mixture of vanillin, iso-vanillin, and veratraldehyde (or their higher homologs). Iso-chavibetol (VII) and iso-eugenol (VIII) show the same behavior toward nitrobenzene and caustic alkali as compounds (III) and (IV) respectively, the iso-eugenol being oxidized to vanillin, while the unchanged iso-chavibetol is remethylated to methyl eugenol for use in the next run. Huon pine oil is therefore available here also as initial material.

The so-called "ethyl vanillin" prepared in similar manner, substituting ethylating for methylating reactions, possesses the formula (1)$HOCC_6H_3$-(OEt)(3)OH(4). Introduced only a few years ago, its odor is equally fine and much stronger than that of vanillin itself. Among the patents covering its manufacturing, are those of Boedecker (*37*) and of Schering (*38*).

E. Ketones

The ketones employed at present include these: methyl amyl, methyl hexyl, methyl heptyl, methyl octyl, methyl nonyl, ethyl amyl, methyl heptenone, ionones (*alpha*, *beta*, and methylated), irone, enanthylidene acetone, benzylidene (benzal) acetone, benzyl acetone, acetophenone, its methyl and dimethyl derivatives, benzophenone, dibenzyl ketone, methyl amylcinnamic, *beta*-naphthyl methyl, acetanisol, and carvone.

Ionones.—In their classical researches upon the nature of the violet perfume, Tiemann and Krüger (*39*) followed some 16 years later by Merling and Welde (*40*), proposed Formulas I–IV for the ionones and irones:



Merling and Welde claimed the synthesis of (IV), but never published any details of their method or constants for their product, although they stated that its odor resembled that of natural irone more closely than do the odors of the ionones.

Ruzicka (*41*) reduced (II) and (III) by hydrogen in the presence of platinum, and obtained (V) in both cases. But this tetrahydroionone was not identical with the tetrahydro derivative prepared by reduction of irone (I) since the latter was optically active whereas the former was

inactive. The two differed also in specific gravity, boiling point, and melting point of their semicarbazones, etc. If (I), (II), and (III) differ only in the position of the nuclear double bond, all three should reduce to the same tetrahydro derivative, and this applies also to (IV). The fact that the reduction product from (I) is not the same as that from (II) and (III) led Ruzicka to the conclusion that (II) and (III) differed from (I) stereochemically and that the ionones possessed a *cis* and the irones a *trans* configuration. In connection with his work in this group, he synthesized also (*42*) a number of new polymethyl cyclohexanones of irone type.

In 1924, Hibbert and Cannon (*43*) studied the extension of this reaction in the preparation of homologs, with especial reference to the connection between odor and structure.

Within recent years, certain of the methylated ionones have been made available for the perfumer.

Piperitone.—The constitution of piperitone has been established as Δ^1-methenone-3 by the work of Baker and Smith (*44*), Schimmel & Co. (*45*), Givaudan & Co. (*46*), Simonsen (*47*), Read, Smith, and Hughes (*48*), Penfold and others; and this compound, isolated from the oil of *Eucalyptus dives*, is now used in considerable amount for the manufacture of thymol and menthol.

Fenchone.—After all, it is only 14 years ago that Ruzicka carried out his interesting and important synthesis of fenchone (*49*) from ethyl levulate and bromacetic ester as initial materials.

Civetone, Muskone, Etc.—The brilliant work of Ruzicka, Kerschbaum, and others in the study of natural products of musk odor, the successful synthesis of these compounds and of many others closely related to them structurally, the numerous noteworthy collateral lines of investigation which these researches led to, the revolutionary effect of some of the results upon certain widely accepted hypotheses (the Baeyer "Strain Theory," for example) and the connections established between odor and constitution, will be found reviewed in recent numbers of the *American Perfumer* (*50*).

Since then, various improvements have been patented on the recovery of civetone from natural civet (*51*) and the synthesis of civetone by heating metallic salts (*e. g.*, the thorium salt) of 8-hexadecene-1,16-dicarboxylic acid (*52*).

Further, the next lower homolog of civetone, viz., Δ^8-cyclohexadecenone,

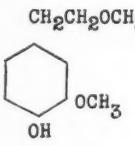
Δ^8-cyclohexadecenone, $\begin{matrix} CH(CH_2)_6 \\ \| \\ CH(CH_2)_7 \end{matrix}\!\!>\!CO$,

has also been prepared synthetically (*53*) by heating the yttrium salt of Δ^7-1,15-pentadecene dicarboxylic acid.

Zingerone.—Although not belonging in the category of perfumes, zingerone, the pungent principle of ginger, is structurally rather closely related to perfumes of the eugenol-vanillin group, *i. e.*, the 1:3:4 derivatives of benzene. Its constitution was determined by Nomura (*54*) to be (4)HO(3)MeO·C_6H_3·CH_2CH_2Ac(1).

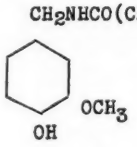
The pungent compound, *capsaicin*, possesses a similar arrangement of its three side chains, (4)HO(3)MeO·C_6H_3·$CH_2NHCO(CH_2)_4CH{:}CHCHMe_2$(1) (*55*).

Pungent Principles



(Zingerone)

(Nomura established constitution)



(Capsaicin)

(8-Me-Δ^6-noneno-vanillylamide)
(E. K. Nelson, Bur. of Chemistry)

F. Acids, Esters, and Lactones

Acids

Phenylactic remains the only free acid used to any extent by the perfumer.

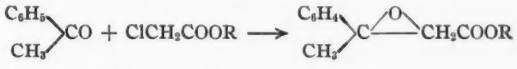
Esters

Lichenol.—Gattefossé (*56*) obtained an oil from oak moss (*Evernia prunastri Ach.*) by digesting it with alcohol and found it to consist almost wholly of a phenolic compound which he christened "lichenol." St. Pfau (*57*) proved that this "lichenol" was actually ethyl everninate, C_6H_2(COOEt:Me:OMe:OH) = 1:2:4:6, which when pure was odorless. He also showed (*58*) that the "sparassol," prepared by boiling with methyl alcohol the fungus *Sparassis ramosa Schäff* (*59*), was the methyl everninate, which was corroborated by Späth and Jeschki (*60*), and that neither of these esters is present as such in the lichens mentioned, but is formed by alcoholysis of the free everninic acid, which composes about 2.8% of the dry lichen, resulting from the long boiling (*61*) with the methyl or ethyl alcohol used.

Esters of Acetylenic Acids.—The heptine carbonates and homologs which resulted from the pure science researches of Moureu and Delange (*62*) have found continuous and increasing use in perfumery, since in dilute form they possess the odor of fresh violet leaves or similar fragrance. It is indicative of the resources of synthetic organic chemistry to point

out that methyl heptine carbonate, for example, can be made from castor oil and the deadly poison gas phosgene as initial materials. Yet the finished product is entirely free from either the unpleasant odor of the castor oil or the toxic properties of the phosgene.

Glycidic Esters.—Methyl phenylglycidic ester, because of its strong strawberry type of odor, is often marketed under the trade name of "C_{16} strawberry aldehyde." It is ordinarily manufactured from acetophenone, chloracetic ester, and sodium ethylate:



Lactones

Undecalactone.—The so-called "C_{14} peach aldehyde," of powerful peach aroma, has been shown to be the γ-undecalactone, $Me(CH_2)_6$-$CH{\cdot}CH_2{\cdot}CH_2{\cdot}CO$, prepared first by Zhukov and Shestakov (*63*), by warming for six hours at 80°C. ten parts of undecylenic acid with eight of concentrated sulfuric acid.

Angelic Lactone and Ambrettolide, two exceedingly interesting musk-scented constituents of well-known essential oils, have already been reviewed in the *American Perfumer* (*64*).

G. Castor-Oil Products

For those who are interested in the general subject of castor-oil products, I have prepared the following slides as a conspectus of some of their reactions.

Castor-Oil Products (1)

$CH_3(CH_2)_5CH(OH)CH_2CH{:}CH(CH_2)_7COOH$
(ricinoleic acid)

+ distillation + dim. press. ⟶ $CH_3(CH_2)_5CHO$ + $CH_2{:}CH(CH_2)_8COOH$
(*n*-heptanal) (undecylenic acid)

+ KOH fusion ⟶ $CH_3(CH_2)_5CH(OH)CH_3$ + $CH_3(CH_2)_5COCH_3$ +
(2°-octyl alc.) (Me hexyl ketone)
$HOOC(CH_2)_8COOH$
(sebacic acid)

+ ozone ⟶ $CH_3(CH_2)_5CH(OH)CH_2COOH$ + $HOOC(CH_2)_7COOH$
(β-hydroxy pelargonic) (azelaic acid)

Castor-Oil Products (2)

$CH_3(CH_2)_5CHO + PCl_5 \longrightarrow CH_3(CH_2)_5CHCl_2$, + alkali ⟶

$CH_3(CH_2)_4C{:}CNa + CO_2 \longrightarrow CH_3(CH_2)_4C{:}C\text{-}COONa$

$CH_3(CH_2)_4C{:}CNa + ClCOOR \longrightarrow CH_3(CH_2)_4C{:}C\text{-}COOR$
(Me heptine carbonate)

$CH_2{:}CH(CH_2)_8COOH + Ox \longrightarrow HOOC(CH_2)COOH$ (sebacic)

$CH_2{:}CH(CH_2)_8COOH + KOH\ fusion = CH_3(CH_2)_7COOH$ (pelargonic)

$CH_2{:}CH(CH_2)_8COOH + H_2SO_4\ conc. + 80° \longrightarrow CH_3(CH_2)_6\overset{\overset{\text{O}}{\frown}}{CH(CH_2)_2}CO$
(gamma-undecalactone = "Peach aldehyde")

$CH_3(CH_2)_5CH(OH)CH_2COOH + reduction \longrightarrow CH_3(CH_2)_7COOH$

$CH_3(CH_2)_7COOH \longrightarrow CH_3(CH_2)_7CH_2OH \longrightarrow CH_3(CH_2)_7CHO$
(*n*-nonanal)

Castor-Oil Products (3)

$CH_3(CH_2)_5CH(OH)CH_3 + Ox \longrightarrow CH_3(CH_2)_5COCH_3$

$C_6H_{13}COCH_3 + PCl_5 \longrightarrow C_6H_{13}CCl_2CH_3 \longrightarrow C_6H_{13}C{:}CNa$

$C_6H_{13}C{:}CNa + CO_2 \longrightarrow C_6H_{13}C{:}C{\cdot}COONa$

$C_6H_{13}C{:}CNa + ClCOOR \longrightarrow C_6H_{13}C{:}C{\cdot}COOR$
(Me octine carbonate)

$C_6H_{13}COCH_3 + Br{\cdot}CH_2{\cdot}COOR + NaOR\ (or\ NaNH_2) \longrightarrow$ (Darzens)

$C_6H_{13}C(Me){\cdot}CH{\cdot}COOR$
$\quad\quad\ \backslash O /$

$C_6H_{13}C(Me)CH{\cdot}COOH + vac.\ distn. \longrightarrow C_6H_{13}{\cdot}CH(Me)CHO + CO_2$
$\quad\quad\ \backslash O /$ (*i*-lauric aldehyde)

$C_6H_{13}COCH_3 + Br{\cdot}CH_2{\cdot}COOR + Zn \longrightarrow C_6H_{13}C(Me)(OH)CH_2COOR \longrightarrow$

$C_6H_{13}C(Me){:}CH{\cdot}COOR + H_2 \xrightarrow{Ox} C_6H_{13}CH(Me)CH_2CH_2OH \longrightarrow$

$C_6H_{13}CH(Me)CH_2CHO$ (Me-3-nonanal-1)

H. Nitrogen Derivatives

The nitro musks, such as musk xylol, musk ketone, and musk ambrette, continue to be widely used, as do also the esters of anthranilic acid, especially the methyl ester. The esters of methylanthranilic acid, *o*-MeNH C_6H_4COOR, have also been introduced, but are naturally more expensive and hence less frequently employed.

Patterning after nature, indole and skatole find use in small amounts, especially in blends of jasmine type.

An interesting newcomer is *p*-methyl quinoline, which is recommended for blends of honey-like aroma.

The Future of the Perfume Industry

It is but a few years ago that, while the use of synthetics in soaps and cheap perfumes was tolerated, the addition of such products to a fine natural floral blend was regarded as decidedly objectionable. Day by day this prejudice is being overcome, as new compounds of delicious fragrance emerge from the laboratory of the synthetic organic chemist, and the percentage of such products in all classes of perfumes is steadily mounting. My good friends among the growers of flowers for perfume

regard me as heretical and even sacrilegious in expressing the opinion that the day is not far distant when the great flower fields of southern France will be devoted mainly to supplying visitors to the Riviera with cut flowers, and as raw materials for the manufacture of perfumes they will give place to the laboratories and factories of synthetic organic chemistry. To any one familar with the history of dyes and drugs and in touch with the trend of recent progress in the perfume field, such a conclusion is certain and ineluctable, and therein lies the great hope and promise for the future of the perfume industry of our own land, where labor costs are so high in comparison with other countries, for the percentage of labor entering into the cost of the synthetic is generally far less than that involved in growing, cultivating, harvesting, and preparing floral products.

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(*46*) GIVAUDAN & Co., *Perfumery Essential Oil Record*, **12,** 80 (1921).
(*47*) SIMONSEN, *J. Chem. Soc.*, **119,** 1644 (1921).
(*48*) READ, SMITH, and HUGHES, *ibid.*, **125,** 129 (1924).
(*49*) RUZICKA, *Ber.*, **50,** 1362 (1917).
(*50*) BOGERT, *Am. Perfumer*, **24,** 15–7, 235–8, 357–8 (1929).
(*51*) RUZICKA to SOC. ANON. M. NAEF & Co.; German Pat. 484,762 (Jan. 18, 1927); U. S. Pat. 1,720,748.
(*52*) SOC. ANON. M. NAEF & Co., Swiss Pat. 136,543 (Oct. 9, 1928).
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(*56*) GATTEFOSSÉ, *Parfum. moderne*, **4,** 6 (1911).
(*57*) ST. PFAU, *Parfums de France*, No. **16,** 137 (May, 1924).
(*58*) ST. PFAU, *Ber.*, **57B,** 468–70 (1924).
(*59*) FALCK, *Ber.*, **56B,** 2555 (1923); WEDEKIND and FLEISCHER, *ibid.*, **56B,** 2556–63 (1923).
(*60*) SPÄTH and JESCHKI, *Ber.*, **57B,** 471–4 (1924).
(*61*) *Perfumery Essential Oil Record*, **15,** 259 (1924).
(*62*) MOUREU and DELANGE, *Bull. soc. chim.* [3], **29,** 648 (1903).
(*63*) ZHUKOV and SHESTAKOV, *J. Russ. Phys.-Chem. Soc.*, **40,** 830–9 (1908); *Chem. Abstr.*, **3,** 1148 (1909).
(*64*) BOGERT, *Am. Perfumery*, **24,** 357–8 (Aug., 1929).

It is surely more than a coincidence that the period of America's greatest industrial and economic progress has also been the period in which she has given most generous support to scientific research.—*The Index*, The New York Trust Co., Dec., **1930.**

THE STANDARDIZATION OF CHEMICAL NOMENCLATURE

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In addition to the reporting of some new rules relating chiefly to the written form of the names of organic compounds, this article includes the more important other general rulings pertaining to accepted nomenclature standards and a classified list of references to sources of information thought likely to be helpful in guiding present-day usage. Further work now actively in progress is mentioned.

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The number of chemical words is very large. There are so many compounds to be named. In the pronunciation, spelling, and written form of these words much variation is to be found. It would be well if greater uniformity could be obtained. Exactness is important in stating chemical information just as it is important in the chemical laboratory and there are pedagogic as well as cultural advantages in uniform good usage. Certain standards have been set up and further work in this direction is being done each year. An effort will be made here to give the more important general rulings, to tell where other information can be found and to mention briefly the further work now actively in progress.

Pronunciations

There is no authoritative standard for chemical pronunciations. The dictionaries differ. An effort to set up some standards is being made now by the Committee on Nomenclature, Spelling, and Pronunciation of the American Chemical Society and it is planned to publish a report as soon as possible.

Nomenclature Rules

It is not the purpose here to trace the history of the development of modern chemical nomenclature but merely to give information thought likely to be helpful in guiding present-day usage. There are still many disputed points; only matters which seem to be pretty definitely settled will be considered.

The nomenclature committees of the International Union of Chemistry, in particular the committee for organic chemistry, have made considerable progress in the formulation of guiding rules but final decisions have been delayed, partly because the obtaining of international agreement is naturally a slow process and partly because of a desire to permit German chemists, who were not represented until recently, to participate in the undertaking.

In 1923 the Nomenclature Committee of the British Chemical Society and that of the American Chemical Society agreed on ten rules covering

* Chairman of the Committee on Nomenclature, Spelling, and Pronunciation of the American Chemical Society.

some of the more commonly disputed points. Some of these relate to endings which have a classification significance. These rules follow:

1. In naming a compound so as to indicate that oxygen is replaced by sulfur the prefix *thio* and not *sulfo* should be used (sulfo denotes the group SO_3H); thus, HCNS, *thio*cyanic acid; H_3AsS_4, *thio*arsenic acid; $Na_2S_2O_3$, sodium *thio*sulfate; $CS(NH_2)_2$, *thio*urea. The only use of *thio* as a name for sulfur replacing hydrogen is in cases in which the sulfur serves as a link in compounds not suitably named as mercapto derivatives; thus, $H_2NC_6H_4SC_6H_4NH_2$, thiobisaniline. *Hyposulfurous acid*, not hydro sulfurous acid, should be used to designate $H_2S_2O_4$.

2. The word *hydroxide* should be used for a compound with OH and *hydrate* for a compound with H_2O. Thus, barium hydroxide, $Ba(OH)_2$; chlorine hydrate, $Cl_2 \cdot 10H_2O$.

3. Salts of chloroplatinic acid are *chloroplatinates* (not platinichlorides). Similarly salts of chloroauric acid are to be called *chloroaurates*.

4. Hydroxyl derivatives of hydrocarbons are to be given names ending in *-ol*, as glycer*ol*, resorcin*ol*, pinac*ol* (not pinacone), mannit*ol* (not mannite), pyrocatech*ol* (not pyrocatechin).

5. The names of the groups NH_2, NHR, NR_2, NH, or NR should end in *-ido* only when they are substitutents in an acid group, otherwise in *-ino;* thus, MeC(:NH)-OEt, ethyl im*ido*acetate; $H_2NCH_2CH_2CO_2H$, β-am*ino*propionic acid (not am*ido*-propionic acid); $PhNHCH_2CH_2CO_2H$, β-anil*ino*propionic acid; $CH_3C(:NH)CO_2H$, α-im*ino*propionic acid.

6. Hydroxy-, not oxy-, should be used in designating the hydroxyl group; as *hydroxy*acetic acid, $HOCH_2CO_2H$, not *oxy*acetic acid. *Keto-* is to be preferred to *oxy-* or *oxo-* to designate oxygen in the group —CO—.

7. The term *ether* is to be used in the usual modern acceptation only and not as an equivalent of *ester*.

8. Salts of organic bases with hydrochloric acid should be called *hydrochlorides* (not hydrochlorates nor chlorhydrates). Similarly hydrobromide and hydroiodide should be used.

9. German names ending in *-it* should be translated *-ite* rather than *-it*, as permut*ite*. If it seems desirable to retain the original form of a trade name it should be placed in quotation marks, as "Permutit." Alcohols such as dulcitol (German Dulcit) are exceptions.

10. German names of acids should generally be translated by substituting *-ic acid* for *"-säure."* Some well-established names are exceptions, as Zuckersäure (saccharic acid), Milchsäure (lactic acid), Valeriansäure (valeric acid), etc. For a few well-established names it is correct to translate "-insäure" *-ic acid* instead of *-inic acid*. *E. g.*, Acridinsäure is acridic acid. Names ending in "carbonsäure" are to be translated *-carboxylic acid* (not *carbonic acid*).

The Written Form

Conflicting usage is very common in the written form of organic names in that some use a single word without hyphens, as *phenyldiethylcarbinol*, some hyphenate, thus *phenyl-diethyl-carbinol*, and others split such names into parts, thus *phenyl diethyl carbinol*. It is considered good practice to limit the use of hyphens in organic names to the attachment of position numbers and symbols and the like, as *1-sec-butyl-4-iodobenzene* and α-

amino-m-toluic acid. Some chemical names are properly single words and others are properly made up of two or more separate words. In an effort to help bring about better uniformity in practice in this respect and to provide other information useful in name construction, the following rules have been prepared, after careful study, by a committee of organic chemists named jointly by the Division of Organic Chemistry and the Division of Chemical Education of the American Chemical Society. The work was done under the active leadership of Charles D. Hurd. They have been approved by the American Chemical Society's general nomenclature committee and were adopted as official standards by the Council of the Society at its meeting in Indianapolis, March 30, 1931.

1. When a hydrogen atom of a compound is substituted by another atom or group, the name of this compound may be retained as the root of the name for the substituted compound. In such names, the prefix (denoting the substituent) is to be directly attached to the root and not spaced from it.

The position of monosubstituents is never labeled with compounds whose replaceable hydrogens are all equivalent, as methane, acetylene, benzene, ketene, hydrazine, carbinol, acetic acid, glyoxylic acid, acetone, arsine, etc. With compounds which contain more than one type of replaceable hydrogen, such as toluene, aniline, propionic acid, benzoic acid, hydroxylamine, acetophenone, furan, etc., ambiguity is avoided by labeling the position of substitution with numerals or with such labels as ortho or *o*-, meta or *m*-, para or *p*-, alpha or α-, omega or ω-, etc.

Examples:

diphenylmethane	and not	diphenyl methane
phenylacetylene	and not	phenyl acetylene
chlorobenzene	and not	chloro benzene
dimethylketene	and not	dimethyl ketene
phenylhydrazine	and not	phenyl hydrazine
phenyldiethylcarbinol	and not	phenyl diethyl carbinol
2-methyl-2-hexanol* or methyl-2-hexanol-2 or 2-methylhexanol-2	and not	2-methyl 2-hexanol; methyl-2 hexanol-2; 2-methyl hexanol-2
o-chlorophenylacetic acid	and not	*o*-chlorophenyl acetic acid
methylallene	and not	methyl allene
2,4,6-tribromophenol	and not	2,4,6-tribromo phenol

* Whether the numerals should be "fore" or "aft" or "fore and aft" is at present a debatable question.

1*a*. "Amine" is regarded as a contraction of "ammonia," and thus is used as the root to which the names of the substituents are directly attached as prefixes. This makes for uniformity with "arsine," "aniline," "hydrazine," etc., and distinguishes it from such names as alcohol, ether, or ketone which only represent types. Thus. methylamine is preferred to methyl amine, ethylenediamine to ethylene diamine, triphenylarsine to triphenyl arsine, *N,N*-dimethylaniline to *N,N*-dimethyl aniline and *p*-tolylhydrazine to *p*-tolyl hydrazine.

2. Since there is no definite unsubstituted compound which is designated by *alcohol*, *ether*, or *ketone*, these terms are always used as separate words.

Examples:

ethyl alcohol
n-butyl alcohol
dimethyl ether
ethyl methyl ether and not ethylmethyl ether
dimethyl ketone
ethyl methyl ketone and not ethylmethyl ketone
p-bromophenyl *m*-tolyl ketone

3. If two words are used in naming *aldehydes* or *nitriles*, the first word is the same as the first word of the name of the corresponding acid. If, as is usually the case, one word is used for these names, the first word of the name of the acid is suitably altered to become a prefix. Usually, this alteration is a detachment of *ic* for aldehydes, as acetaldehyde, propionaldehyde, contractions of acetic aldehyde and propionic aldehyde, respectively. However, in naming benzaldehyde, *oic* has been detached. With nitriles, an *o* is usually introduced for euphony, as acetonitrile and butyronitrile, but the contraction may go back to an *o* as propionitrile.

4. Isocyanate is a separate word. Thus, C_6H_5NCO is phenyl isocyanate. This practice is correct for esters in general.

5. In naming metallo-organic compounds, the alkyl groups should precede and be directly attached to the name of the metal. Thus, methylmercuric iodide, diethylzinc, ethylmagnesium bromide, tetraethyllead, tetramethylgermanium, etc.

6. It is recommended that in aliphatic unsaturated compounds, the use of the delta be discontinued.

Examples:

3-Buten-1-ol, $CH_2(OH)CH_2CH{:}CH_2$ instead of Δ^3-1-butenol
1-Penten-3-one, $CH_2{:}CHCOCH_2CH_3$ instead of Δ^1-3-pentenone
2,4-Pentadien-1-ol, $HOCH_2CH{:}CHCH{:}CH_2$ instead of $\Delta^{2,4}$-1-pentadienol
3-Hexene-2,5-diol, $CH_3CH(OH)CH{:}CHCH(OH)CH_3$ instead of Δ^3-2,5-hexenediol
4-Heptene-2,3,6-trione, $CH_3COCOCH{:}CHCOCH_3$ instead of Δ^4-2,3,6-heptenetrione
2,5,7-Octatrien-4-one, $CH_3CH{:}CHCOCH{:}CHCH{:}CH_2$ instead of $\Delta^{2,5,7}$-4-octatrienone

It is our very strong hope that chemists in general and editors and publishers in particular will follow these new rules. This applies to the other rules, too, but they are much better established in usage.

References

There is no one place to which interested chemists can turn for full information on chemical nomenclature. It is not feasible to assemble here all of the rulings and forms established as standards but references can be given to the sources considered most useful for such an inquiry.

For *listed names of individual compounds and elements* see—

(*a*) The Second Decennial Index to *Chemical Abstracts* or any recent annual subject index.*
(*b*) The subject indexes to *British Chemical Abstracts*.
(*c*) Webster's "New International Dictionary" (for the commoner compounds).
(*d*) Hackh's "Chemical Dictionary."
(*e*) The index to Roscoe and Schörlemmer, "A Treatise on Chemistry" (for inorganic compounds).
(*f*) The indexes to the various volumes of Mellor's "Comprehensive Treatise on Inorganic and Theoretical Chemistry" (for inorganic compounds).
(*g*) Dorland's "The American Illustrated Medical Dictionary," 15th edition.
(*h*) The index to the American Medical Association's "New and Nonofficial Remedies" (for medicinal substances).

For *organic ring systems* see—

(*a*) PATTERSON, *J. Am. Chem. Soc.*, **47,** 543–61 (1925); **50,** 3074–87 (1928).
(*b*) The Ring Index which is a part of the introduction to the subject index to *Chemical Abstracts* for each year since 1916.
(*c*) STELZNER, "Literatur-Register der organischen Chemie," **5,** ix–xv (1926).

For the *names of organic radicals* see—

The Introduction to the subject part of the first and second decennial indexes to *Chemical Abstracts* and that to the 1927 annual index of the same journal. These lists are complete to date; a few additions are listed each year in the annual indexes.

For the *Geneva system* of naming organic compounds (many of the Geneva names are now not commonly used) see—

PICTET, *Arch. sci. phys. nat.* [3], **27,** 1–36 (1892).
TIEMANN, *Ber.*, **26,** 1595 (1893).
For examples see Beilstein's "Handbuch der organischen Chemie," fourth edition, in which Geneva names are used systematically.

For a *discussion of organic nomenclature* with particular reference to names for indexing see—

(*a*) PATTERSON and CURRAN, *J. Am. Chem. Soc.*, **39,** 1623–38 (1917).
(*b*) The Introduction to any subject index to *Chemical Abstracts* published since 1916, where the discussion is brief.

For the *rules under consideration by* the nomenclature committees of *the International Union of Chemistry* see—

(*a*) Biochemistry
Bull. soc. chim. biol., **5,** 95–109 (1923).
Ibid., **8,** 1211–6 (1926).

* In building the indexes to *Chemical Abstracts* special care has of necessity been used to observe what is considered best usage in nomenclature. These indexes are naturally comprehensive and extensive and accordingly reference is made to them and accompanying compilations, the hope of extending their usefulness having been allowed to outweigh reluctance to speak of the work of my own office as standard.

Bull. trimestr. assocn. élèves école sup. brasserie univ. Louvain, **27**, 139–43 (1927).
Bull. soc. hyg. aliment., **16**, 277–82 (1928).
Schweiz. Apoth. Ztg., **66**, 193–7 (1928).

(*b*) Inorganic chemistry
Ind. Eng. Chem., **18**, 320–1 (1925).
Chem. Weekblad, **23**, 86–99 (1926) (In English).
Bull. soc. chim., **43**, 289–300 (1928).
Gazz. chim. ital., **58**, 883–91 (1928).
Rec. trav. chim., **48**, 652–63 (1929).

(*c*) Organic chemistry
Ind. Eng. Chem., **18**, 321–3 (1926).
Rec. trav. chim., **48**, 641–51 (1929).

For *reports of the American Chemical Society's Nomenclature Committee* on specific problems, as the naming of pectic substances, see—

Proc. Am. Chem. Soc. (These reports are made each year at the spring meeting and usually appear in the *Proceedings* part of the May number of *J. Am. Chem. Soc.*)

For *miscellaneous articles or parts of articles on nomenclature* see—

Chemical Abstracts subject index entries under the heading *Nomenclature*.

South African Gold Nearing Exhaustion. At the end of fifteen years the present gold mines of South Africa, which now supply over half of the entire world output, are expected to be near the end of their gold production, F. Lynwood Garrison, Philadelphia mining engineer, warned the American Institute of Mining and Metallurgical Engineers meeting recently in New York.

The future production of the Witwatersrand's gold mines, said Mr. Garrison, depends on the possibility of mining and milling profitably the large tonnage of relatively low-grade ores known to exist in that area.

The director of the U. S. Mint, Robert J. Grant, presented figures showing that the production of new gold is mounting throughout the world following the decline that set in after the World War. Since the discovery of America, 40,000 tons of gold have been produced throughout the world, Mr. Grant estimates.

In the production of new gold, he said South Africa not only stands first just now but in recent years has been far in the lead of all other regions. In the future economic development of the world, therefore, the South African supply of the standard metal is of paramount importance. During the next few years, African production will become even more important despite the critical technical problems at present facing the gold industry of that continent.

Bankers joined with the engineers in discussing whether enough gold is being mined and whether the present business depression is related to the gold supply.

The money users of the nation plan to join forces with the engineers in conserving the gold supply by devising methods of using less gold in their monetary dealings, George E. Roberts, vice-president of the National City Bank, indicated in his discussion.—*Science Service*

UNIVERSITY RESEARCH IN THE EXPERIMENTAL SCIENCES

L. M. Dennis, Cornell University, Ithaca, New York

During the first term of the present university year, the Society of Sigma Xi at Cornell University sponsored a series of ten-minute radio talks for the general public by members of the Departments of Physics and Chemistry upon research lying in their several fields. The writer was requested to close the series with a ten-minute discussion of the general subject of university research, and in his remarks, which are given below, he illustrated for the layman the value of university research as contrasted with the investigation of practical problems, and he emphasized the importance of carefully training the student in the technic of experimentation, and of schooling him correctly to evaluate the evidence that his experiments seem to furnish, and of refraining from public announcement of his results until he has convinced himself that they are accurate and conclusive.

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There is nothing mysterious or unusual about this field of activity, for all of us are born investigators. Every baby, from the moment he begins to creep, starts delving into the mysteries of the unknown, and subjecting everything about him to the tests of his experimental apparatus, his senses. He knocks his head against the leg of a table or pulls the tail of the cat, and thus trains his sense of feeling. He hammers on a tin pan and develops his sense of hearing, and strains that of others. Every object that is not too large he puts into his mouth and exercises his sense of taste.

As he gains in years, his accumulated experience enables him to make more thorough his researches into the unknown, and while the small boy's activities are often of a destructive character, they still serve to widen his information and to develop his power of observation. If he is a healthy, alert lad he is continually putting the questions "Why?" and "What?" to the world about him.

It is this same spirit, this all-consuming curiosity, this irrepressible desire to extend his knowledge of material things and of the forces that affect them, that carry forward and inspire the mature investigator in the experimental sciences of physics and chemistry.

One occasionally hears the criticism that university research in physics and chemistry is "high-brow stuff," a misuse of time and energy, and that the investigators ought to concentrate their efforts upon problems of a practical nature. In reply it can be said that the study of practical questions, while it may lead, and has led, to very useful results, rarely opens up new fields of knowledge. The university investigator, quietly, patiently, and perseveringly pursuing his search for the truth for the truth's sake, and with but little thought of possible useful application of his discoveries, has given us by far the greater number of our epoch-making advances in scientific achievement.

A classic illustration of the extremely important results that may come from university research in pure as distinguished from practical chemistry is furnished by a discovery made by Professor Wöhler in 1828. Up to that time it had been thought that the many chemical compounds which are formed in plant and animal bodies need for their production a so-called vital force, and that they could never be made in the laboratory from inorganic, mineral substances. Wöhler found that urea, a typical secretion of the animal organism, could be prepared from familiar inorganic chemicals, and university research thus opened the way to the tremendous development of synthetic organic chemistry which has given to the world thousands of new compounds, not only such as are of industrial importance, but also many valuable remedies for the diseases that afflict us. It has also made possible the preparation in the laboratory, from that most unattractive substance coal-tar, the hundreds of beautiful dyes and pleasing perfumes that contribute so greatly to our esthetic enjoyment.

Professor Baeyer of the University of Munich carried out, about half a century ago, prolonged laboratory study of the composition of indigo, that familiar and valuable blue dye which was at that time obtained exclusively from the indigo plant in India. His researches paved the way for the production in the laboratory of indigo from familiar chemical substances, and as a result about 1,500,000 acres of land in India were released for the growing of other crops, and the world is now supplied with synthetic indigo much purer and more uniform in composition than that from the natural plant.

Lord Rayleigh took up the experimental study of the density of the gas nitrogen which is the chief constituent of the air. The most vivid imagination could not have suggested a result of any practical importance from such an investigation. But he found that nitrogen from the air is slightly heavier than nitrogen from chemical compounds of that element, and his experiments were of such extreme accuracy that he was sure that the difference could not be due to errors in his measurements. The subject was then investigated by the chemist Ramsay, who, in a series of brilliant researches, found, to the astonishment of the scientific world, that atmospheric air contains five inert gases whose existence had never been suspected. One of these gases is helium, the now familiar gas with which our airships are filled because it will not burn, which thus removes the possibility of such a terrible accident as that which recently occurred to the English airship R-101 in France, the great loss of life there being due to the burning of the combustible gas hydrogen, with which the airship was filled.

These three achievements (and many more, by both foreign and American investigators, could be added to them), give us a clear understanding of the importance and usefulness of the results that may follow from

accurate and conclusive university research that is undertaken without thought of practical application.

Today the problems that confront us in physics and chemistry are usually more complex than formerly, and their study calls for more refined methods, more delicate and accurate apparatus, more elaborate equipment, and better laboratories than were required by the early workers in these fields. But the scientist of the present day has at his disposal such a variety of experimental attacks, so many novel methods of prying into the mysteries of the unknown, that discovery and the application of what has been discovered have carried us, in the last thirty-five years, far beyond even the dreams of our predecessors.

To prepare young men and young women for careers as investigators, it is the function and opportunity of the university to offer courses of instruction which will give them fundamental information concerning their own special field of study and allied branches of knowledge. The university should also strive to develop in its students a scientific habit of thought, and sound and accurate judgment, which are of such supreme importance in achieving what should be, after all, the chief objective of the university—the preparation of young men and young women for enlightened and useful citizenship.

In the special preparation for research, the university should first of all carefully train the student in the technic of experimentation, for a lack of manipulative skill will lead, and frequently has led, both young and mature investigators to inconclusive and misleading results, and sadly erroneous conclusions.

The student must further be schooled in accurately weighing the evidence that his experiments seem to furnish, and to subject this evidence to rigid and thorough tests before announcing his findings.

Hand in hand with experimental ability should walk imagination, sometimes leading the experimenter, sometimes aroused and guided by the laboratory results. Speculation occasionally opens the way to very important advances in science, but the advance itself rests on convincing confirmatory experiments. Statements appear at times in the newspapers or scientific journals describing a spectacular discovery. These statements are only too often merely guesses which are given out in the form of definite conclusions, although they have no support except one or two inconclusive or poorly performed experiments. While a startling guess of this character may impress the uninformed, and give to the guesser a cheap and transient notoriety, it misleads the public, brings sound investigation into disrepute, and those who are acquainted with the subject can clearly see that although such a guess may make a big noise when first shot off, it was fired from a gun of small caliber.

Research in chemistry really got into its stride not much more than a

century ago. At that time, new discoveries were easy, for careful experiments with simple apparatus would almost always add something of value to the then scanty knowledge of the science. Today, after more than one hundred years of progress, experimental research, if it is to be really successful, needs much better equipment than was required by the early workers in the field. The old stage-coach has been succeeded by the complicated locomotive.

It is clear, therefore, that progress in university research in the experimental sciences calls for abundant financial support, and if this is forthcoming, the resulting benefits to our people, in the development of new industries and the improvement and expansion of old ones, in the cure and avoidance of disease and the alleviation of suffering, in the extension of the comforts and conveniences for our daily life, will repay this support a thousand-fold.

Sulfur Fumes Poison Plants. It takes very little of sulfur fumes to poison plants. At the recent meeting of the physiological section of the Botanical Society of America in Cleveland, Dr. P. W. Zimmerman and Dr. William Crocker of the Boyce Thompson Institute for Plant Research, Yonkers, N. Y., reported that a dilution of sulfur dioxide as weak as three or four parts per million of air sufficed to injure the leaves of ordinary plants after only one hour of exposure. Brown or withered areas appeared first along the margins, then in the spaces between the veins.

Slight wilting, however, seems to give the plant partial protection against the action of sulfur dioxide. Plants in this condition resisted double the concentrations that injured their leaves while fresh, even though they were exposed five hours instead of one. Middle-aged leaves were more sensitive than either young or old leaves.

Orchid foliage was many times more resistant to the effects of the gas than were the leaves of other plants studied. They were not injured after a four-hour treatment in a concentration of seventy parts per million of air. However, a high concentration for a longer period injured the leaves and some of the exposed roots.

In another series of experiments the same physiologists, with the collaboration of A. E. Hitchcock, investigated the effects of illuminating gas on plants. The most characteristic symptoms of injury were the curling down of leaves, yellowing of the oldest leaves, and the dropping off of leaves, flowers, and flower buds. The greatest injury occurred at or above 75 degrees Fahrenheit; at 50 degrees and less the plants did not suffer damage.—*Science Service*

Light Accelerates Spoiling of Fats. A careful study of the chemistry of the spoilage of fats by C. H. Lea, of the Low Temperature Station, Cambridge, has revealed the fact that light plays an important part in its development.

Mr. Lea found that under ordinary conditions fresh beef kidney fat keeps well for a certain initial period, and then quickly becomes rancid. When the fat is kept in darkness, there is a longer initial safe period before it begins to spoil.

Bright light has the opposite effect. If the fat is exposed to direct sunlight on a hot day, rancidity sets in very rapidly, and the initial safe period may be almost completely eliminated. If the fat is placed in sunlight long enough for spoilage to start, even subsequent removal to a dark place will not improve matters very much.—*Science Service*

COMPARISON OF AMERICAN AND EUROPEAN FINAL EXAMINATIONS*

ALEXANDER LOWY, UNIVERSITY OF PITTSBURGH, PITTSBURGH, PENNA.

A discussion and comparison of our method of final examination and the European method is given. The chief differences, the advantages and disadvantages of each method are enumerated. The method of conducting final examinations is still a debatable one and involves considerable thought.

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During a recent trip abroad, the writer visited, just at the close of the school year at the time of final examinations, the chemistry departments of many universities in different countries. The differences between their methods of examinations and those to which we are accustomed in our schools were quite noticeable.

The chief difference noted was that our examinations are mainly written while theirs are mainly oral. This leads to the question: what is the purpose of final examinations, and what method accomplishes this purpose most effectively? Is it the written or the oral type, or perhaps both? Then again, why is it that here the written examinations are in vogue with practically no oral, while abroad it is just the reverse? Carefully thinking this matter over, one wonders which is the best method and which accomplishes the best results. Evidently there must be certain advantages and disadvantages attached to both methods and these will be discussed in this paper.

Written Examinations

Advantages. Many of the undergraduate courses are taken by large classes and these can be examined at the same time. It is necessary to prepare only one or perhaps two sets of examination papers. Usually the examinations last from two to three hours. When preparing a written examination, a variety of questions can be formulated to cover the contents of the course and thus really test the knowledge of the students. During the written examination, the student is at perfect ease and is not disturbed. He has ample time to collect his thoughts. To the slow thinker, this method is especially beneficial. He can answer certain questions at once and can spend more time later in working out the others, such as problems, etc. The papers are usually graded by several members of the staff and, in this way, the grading is comparatively simple and more likely to be fair. Then, also, in case of erroneous grading, one can always refer to the papers.

Disadvantages. While there are distinct advantages to written examinations, there are, however, many disadvantages. For example, there is entirely too much time consumed in writing answers, which is somewhat tiresome to the student. He may neglect to insert minor points

* Paper No. 210 from the Chemistry Department.

in his answers and thereby fail to receive full credit. It happens sometimes that the student does not understand the question, and using this method he cannot be aided by any suggestions which would lead him to an understanding of it. Also, irregular practice, such as copying, etc., can be resorted to by the students. The greatest disadvantage in using the written examination is that it does not train the individual to answer questions extemporaneously, which is so important in life. Once the student leaves school and enters his life work, he is very seldom subjected to written tests.

Oral Examinations

We are familiar with the method used in conducting written examinations as practiced in American institutions. It may be of interest to note how a final examination is conducted abroad. The student is called up to the professor's desk, while others of his class remain seated. He is then questioned by his examiners. At most of the universities there are two examiners. The examination lasts approximately ten minutes. While one student is being examined the others are very attentive. After witnessing quite a number of these oral examinations, certain advantages and disadvantages of the method became evident.

Advantages. One of the outstanding advantages of oral examinations is that it trains the student to be self-reliant and a rapid thinker. These qualities help to prepare him for life. Another advantage is that while the student is being examined, the examiner can suggest certain leading questions when he does not have a direct answer. He can answer more fully verbally than in writing and it takes less time. He can be questioned on minor points and in detail. While one student is answering, his fellow students are attentive and thereby gain additional knowledge. The student has no way of resorting to any irregular practice. The oral examination serves the purpose for small classes but is hardly possible for large classes such as we have here.

Disadvantages. During the examination, one notices the nervousness and anxiety of the students in their seats and particularly the one being examined. The professors are also under great strain, since they have to conduct them for several days. It is an exceedingly tiresome task for the examiner and many of them admit it. These examinations are decidedly objectionable to a slow thinker. Taking human nature into consideration, one wonders just to what extent personal favoritism and prejudices can be exercised. The grading certainly cannot be as accurate as for a written examination. Neither can the examination be as comprehensive as a written one. For example, an oral examination which lasts only about ten minutes for each individual can hardly be considered a deciding factor for passing or failing. What written evidence is there in case of an errone-

ous judgment? There is no examination book to refer to. Besides, it is a well-known fact that the average student does not do his best at an oral examination. This fact is very often proved at our oral examinations for master's and doctor's degrees. Another disadvantage is the fact that not all the students are subject to the same examination and it does not seem quite as fair as where all have the same questions.

General Comment

Considering the advantages and disadvantages of both methods and noticing particularly the nervous strain of the students during examination, the writer is still in favor of our own method. He has discussed the problem of examinations with a number of European chemistry professors, and while they still favored their own plan they passed favorable comments about our method.

After due consideration, there is still "food for thought" for everybody concerned.

Depth Produced in Pictures by New Screen Surfaces. Three types of screen which produce the illusion of three-dimensional depth in pictures projected on them were described by Dr. Herbert E. Ives of the Bell Telephone Laboratories to physicists gathered recently in New York at the meeting of the Optical Society of America.

Stereoscopic pictures which stand out in solid relief no matter where you are looking from, can be made either by the construction of the screen or by the use of goggles by the members of the audience. The goggle method has been used with moving pictures but is awkward. The screen method cannot be practically applied to movies as yet.

The depth arises when two eyes see slightly different views of the same scene, as of course they do when observing a real object. Actually two pictures as if taken from spots about two and a half inches apart must be seen at every place in the room.

The new methods require only one photograph taken with a large lens or concave mirror. These can be projected from the front on a screen made of horizontally ribbed cylinders. Or they may be thrown from the back, on a celluloid screen in which cylindrical grooves are cut.

The earlier screen method, described some time ago by Dr. Ives, requires the taking of a large number of pictures from all angles. This form of screen consists of transparent cylindrical rods, the picture being projected from the rear.—*Science Service*

Manganese Found Unnecessary for Growth of Green Plant. Manganese, strengthener of steels, lately believed to be equally important as a vivifier of green plants, may not be as universally necessary for vegetable life as has sometimes been assumed. Experiments performed at Iowa State College by Dr. Norman Ashwell Clark and Claude L. Fly apparently lend support to the doubters of the importance of manganese in the life of green plants.

In order to simplify their procedure, Dr. Clark and Mr. Fly used a floating water plant known as Lemna. They grew this in culture solutions both with and without manganese, and found that it would thrive in the total absence of that element. In concentrations of more than one part per million, manganese even exerted a poisonous effect. The experiments are reported in full in *Plant Physiology*.—*Science Service*

CHEMISTRY COURSES IN PRE-MEDICAL EDUCATION*

JACK P. MONTGOMERY, UNIVERSITY OF ALABAMA, UNIVERSITY, ALABAMA

The American Medical Association has established as the minimum requirements in chemistry, for admission to medical colleges, eight hours of inorganic chemistry, including qualitative analysis, and four hours of organic chemistry. In a large number of colleges and universities this minimum is supplemented by additional work in organic chemistry and at least four semester hours in quantitative analysis, with the occasional further addition of elementary physical chemistry. This practice has resulted in such fine recognition by the medical colleges that they are now giving great preference to those students with the maximum of chemistry and merely the minimum is far from sufficient. The trend is toward student guidance into more and more chemistry in his pre-medical work and the opinion is expressed that further developments should include a more thorough organization of chemistry teaching, for such students, along the lines of a course which shall be unified in respect to inorganic, organic, and quantitative, and at the same time sequential within itself and in respect to physiological chemistry which is early encountered in the medical college.

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Not so very long ago when a young fellow wanted to study medicine he hied himself to a medical school, paid his fees, and started to work. About all he had to show the authorities were evidences of good character, recommendations from one or two active physicians, ability to pay the tuition fees required, and some determination to work. The medical school did not presume that he had had any special preparation in language or science. Even when the prospective medical student could show evidence of previous courses in physics and chemistry the medical school insisted that he take general chemistry over again. Pre-medical students of today know that getting into a medical school is now far from being such a simple matter. Not only must he present various recommendations and stand an aptitude test, but the Board of Admissions is likely to scrutinize his record right back through his high-school and college days, and if anything in that record of the past few years is wrong he may have to decide reluctantly to become a business man instead of a physician. Through the joint efforts of the American Medical Association and the American Association of Medical Colleges many of the fly-by-night medical schools and "degree factories" have been eliminated and medical education thoroughly standardized. There is quite a contrast in the foregoing, and yet a period of time of only about twenty-five years was involved in the change. It would surprise many of our pre-medical students to learn that a number of our most prominent physicians, including some of our medical faculties, never had to endure the pre-medical course as we now understand it.

* Presented before the Division of Chemical Education of the A. C. S. at the Indianapolis meeting, March 30–April 3, 1931.

The departments of chemistry, biology, and physics in most of the American colleges and universities have become greatly developed and strengthened in the past quarter century. About eighteen or twenty years ago, when these departments began to win recognition, the better medical colleges began to require two years of college work for admission. Even these medical colleges still taught general chemistry and did not expect much preparation in science prior to admission to the medical course. It was soon apparent, however, that the very type of student who wanted to study medicine was the one who in his college course had elected chemistry, biology, and physics. This fact soon led the medical colleges to require not only the two years of college work but that the two years should include a certain number of hours in laboratory science. The arts colleges of our various universities, noting the trend of the times and desiring to be of guidance to the prospective medical student, began, about seventeen years ago, to organize pre-medical courses with specific curricula. This movement, participated in by a few at first, has spread to nearly all of the important institutions. It is noteworthy that the administration of the pre-medical course is almost entirely in the hands of the non-medical faculty. This is the case even where the medical college is on the same campus, or in the same city, as is the arts college.

The American Medical Association early sought to standardize certain minimum requirements for admission to medical colleges, but at the same time has wisely advised that the minimum really be considered just what the word implies. At the present time only the exceptional student, having valuable assets of maturity, personality, and proved ability, can hope to gain admission to a Class A medical college when offering merely the minimum. For 1930 the minimum requirements were sixty semester hours in an approved college. The minimum requirements in chemistry were twelve semester hours, including eight in inorganic chemistry, with qualitative analysis, and four in organic chemistry. Most of the universities and colleges, with a prophetic eye, in the establishment of pre-medical courses, have always required more chemistry than the minimum of the American Medical Association. One result of the thorough attention given to chemistry in pre-medical education was that students from institutions emphasizing chemistry had a better chance of admission to medical colleges. Another result is that the member institutions of the American Association of Medical Colleges look to the arts colleges to furnish students already well taught in chemistry. As an evidence of this, the only chemistry now offered in medical schools is physiological chemistry. It is obvious that merely the minimum requirements of the American Medical Association could hardly be expected to fit the student for physiological chemistry or to give him any background in *materia medica*. Medical colleges actually expect a much better preparation than the minimum in chemistry

and it is a gratifying fact that in most of our pre-medical courses the minimum is wisely greatly exceeded.

A review of current catalogs of sixty institutions listing, in one form or another, pre-medical courses reveals a very healthy situation in most of them regarding the importance of chemistry in pre-medical training. It is regrettable, however, that some of the institutions reveal a weakness, or a lack of realization of their importance, in advising prospective medical students as to the great desirability of some of the chemistry courses which they offer, in general, to the whole body of students. The catalogs examined were those of Separated State Universities, State Universities including Land-Grant Colleges, Separated Land-Grant Colleges, Independent Endowed Colleges, and Denominational Colleges. Almost without exception, the closer the relation of the institution with a medical college, from the administration standpoint or geographically or both, the greater is the catalog description of pre-medical requirements and the detailed advice to pre-medical students concerning chemistry courses regarded as essential, while the poorest advice is available in the cases of some Denominational Colleges and Independent Endowed Colleges which have little or no relation with medical colleges. While not unexpected, this result may serve to call to the attention of chemistry teachers in these institutions the importance of becoming informed of the situation.

Following is a compilation of the chemistry courses included in the pre-medical curricula of the institutions referred to above:

Eleven provide the minimum requirements of the American Medical Association, but make no further suggestions. Nine of the eleven list other courses in chemistry in addition to the minimum, but they appear to be entirely elective.

Seventeen provide the minimum requirements and strongly urge the election, on the part of prospective medical students, of additional chemistry courses, including a second semester of organic and four hours of quantitative analysis. Five of these, in addition, suggest elementary physical chemistry as desirable.

Twenty-eight require, in addition to the minimum, four hours in second-semester organic chemistry and four hours in quantitative analysis. Fifteen of these include also, either in plain terms or by implication, four hours of elementary physical chemistry. Five suggest additional courses in both qualitative and quantitative organic.

Although somewhat aside from the main discussion, the details of student guidance in the various catalogs may be of interest. Eleven institutions with state support and two Independent Endowed Colleges strongly urge pre-medical students to graduate with the A.B. degree before beginning medicine and to include from twenty-four to thirty hours of chemistry, comprising the American Medical Association minimum

with the addition of second-semester organic, four hours of quantitative, four hours of elementary physical, and some electives in chemistry. Some of these institutions, and others, provide for the A.B. degree upon completion of a specific three-year pre-medical course followed by the first year in medicine, the year in medicine in some cases to be taken in the medical school of the institution awarding the degree and in other cases to be taken at any Class A medical school. So far as can be learned, all these three-year medical courses include the American Medical Association minimum with the addition of four hours in second-semester organic and four hours in quantitative. Some of them include elementary physical chemistry and electives in chemistry. A few institutions still offer a course, which is rapidly becoming obsolete but which was popular some years ago, the combined B.S.-M.D. Under this plan the student takes two years of specific pre-medical work followed by four years of medicine. At the end of the second year of medicine the degree "B.S. in Medicine" is given and the M.D. degree is awarded at the end of the fourth year in medicine. In all cases the pre-medical part of the work included the American Medical Association minimum in chemistry with four additional hours in organic and four hours in quantitative. Finally, the more isolated colleges give practically no guidance to students except to list the American Medical Association minimum.

Those of us who seek to place our pre-medical students in the best medical schools are fully aware of the following facts: (1) A few medical schools require for admission an A.B. degree including from twenty-four to thirty hours in chemistry. (2) All the medical schools give preference to those holding the A.B. degree with a major of thirty hours in chemistry. (3) The student who has had a three-year pre-medical course, with from twenty to twenty-four hours in chemistry, has an immeasurably better chance for admission to a medical school than the two-year man, even when the American Medical Association minimum requirements with additional hours in chemistry have been met. (4) It is now practically impossible for any student to enter medical college with the minimum American Medical Association requirements in chemistry.

From the above it is evident that our wide-awake departments of chemistry, in their contribution to pre-medical education, have been consistently anticipating the requirements of the best medical colleges. Admission to medical colleges has rapidly developed into a competition in which the well-prepared student is likely to have a great advantage over about half a dozen others applying for the same place. In this respect the medical colleges are giving excellent recognition to the teaching of chemistry in the arts divisions of our universities and colleges. This is a source of great gratification to many chemistry teachers, but it is likely that we shall have to do even more as we proceed with this particular phase of our work.

Since the study of medicine is itself so well standardized and organized, the time is approaching when the chemistry courses in pre-medical education will have to be unified, and at the same time made properly sequential. Some institutions already have special sections for pre-medical students in inorganic chemistry, including qualitative analysis, organic chemistry, and quantitative analysis. Even though these courses are taught by three different men it is possible to unify the entire twenty hours so that there may be constant repetition of certain principles with the avoidance of repetition of less essential details, the idea being to deliver the student to the physiological chemistry course in the medical school in such good order that he need not waste time and energy getting under way.

AN INEXPENSIVE WATER-COOLED CONDENSER

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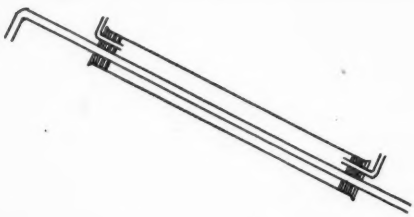
Many elementary laboratory manuals describe air-cooled condensers in experiments illustrating the process of distillation. This is presumably done because of the apparently prohibitive cost of the water-cooled condenser. The condenser illustrated below can be assembled for about ten cents and quite efficiently illustrates the process of separating liquids of different boiling points. The price mentioned does not include the rubber tubing for water connection. Two feet of this are necessary and cost about fifteen cents. If desired, very short pieces can be used and connected to glass conveying tubes.



The apparatus required includes: one foot of glass tubing 17 mm. inside diameter, two and one-half feet of glass tubing 4 mm. inside diameter, and two number two two-hole rubber stoppers.

Since the stoppers must be moved a considerable distance on the condenser tube it sometimes helps if the hole of the stopper is moistened with glycerin.

If desired, number one stoppers and a smaller water jacket may be chosen. The smaller the water jacket the more efficient is the condenser for the amount of water used. It may be shortened also about two inches without impairing the efficiency greatly, since about 99% of the condensation takes place in the first ten inches of the tube.

In the event that water connections are not available, a siphon effect may be used.

CHEMISTRY AND VOCATIONAL GUIDANCE

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Every high-school student will eventually enter some vocation. It is a well-known fact that an alarming number of individuals drift into occupations for which they are neither fitted nor prepared. This article tells how the chemistry course may be an aid in helping the individual find a vocation to his liking and for which he is fitted.

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Chemistry touches every person's life, no matter what his calling. The food we eat, the clothes we wear, the car we ride in, and the film we view at the theater all are touched by the wand of the chemist and have their beginnings in some chemical process. The work of every man and woman is dependent partially or wholly on a knowledge of some chemical operation.

There is an intense need in our schools today of more and better vocational guidance. More than fifty per cent of all boys graduating from high school drift by chance into some occupation for which many of them are neither suited nor trained. Worse than that, many remain there indefinitely, discontented, unhappy, and unfitted for their work. In a study made in our high school of the vocational preferences of two hundred eighty boys, one hundred fifteen had not the slightest idea or plan concerning their vocation, thirty-six expressed a preference for engineering, and eighteen for aviation. The interests of the remainder were centered in thirty-three other lines of work. A careful study of the data and a questioning of several individuals indicated that their choices were based on very superficial considerations. The glamor and romance of the engineer in trackless wilds and the exhilaration of soaring through the clouds were the main causes for the choices of the vocations of engineering and aviation. The knowledge that engineering required considerable skill and talent along mathematical lines was a serious disappointment to several who had flunked their algebra. No thought had been given to the basic principles involved, the physical and mental fitness for the work, the opportunities for advancement, and the length and cost of the training.

True, some of the larger and better-equipped schools have experts, who through group and individual contacts give vocational guidance and stimulate students to choose a vocation and evaluate it in terms of their fitness for it. The number of such schools is limited, however, and in the majority of high schools vocational guidance is given very little consideration or is neglected entirely.

Modern pedagogy has revealed to us the relative unimportance of subject matter as an end. Rather the subject matter is the means toward the end of developing the student along the lines of the seven cardinal principles with which every student of education is familiar. Far from the least important of these objectives of secondary education is the choosing of and

training for a life work. One should first become acquainted with many occupations, then choose one, then prepare for it. The school should play a leading part in the first two phases as well as the third.

If high-school chemistry is to be conceived as a study to be developed along practical and cultural lines and not as a subject taught merely for the accumulation of abstract chemical information, what an opportunity we have here for making it of use in helping our students solve this perplexing problem of deciding what they are to do when they finish school!

It is not inferred that the author advocates turning the chemistry course into a course on vocations, but no one can gainsay the fact that the contacts made with so many industries and lines of work cannot but be of value in assisting the student to consider the possibilities of finding his life work. The wide-awake chemistry teacher will keep in mind the part that the study of the various phases and applications of chemistry can play in assisting the student with the solution of this important problem. In formulating objectives for our course in chemistry let us not forget the one that will reveal to the student, through the many ways in which chemistry affects our lives, possibilities for choosing a vocation that will make him of more value to society and himself than he would be otherwise.

As a concrete example, in an ordinary course of high-school chemistry, taught with the aid of a very well-known and widely used text, different parts of the course dealt with practical information directly connected with many vocations, which with a few words of comment by the teacher was of great value to the student in the way of giving him information concerning them. Here are some of the vocations referred to; commercial and engineering chemistry, medicine, pharmacy, dentistry, electrical and mining occupations, plumbing, printing, photography, bricklaying, masonry, papermaking, painting, and decorating. To the teacher keeping this objective in mind many more might be noticed.

In every town and city there are usually one or more large industries that well warrant any time spent in making a special study of the chemical aspects of them. The author has in mind a wood distillation plant operated by the Ford Motor Company in his own town to which he takes his class for an annual field trip. To many of the boys their knowledge and liking for chemistry distinctly attracted them to this plant and several will work there and be willing to forego other opportunities until they can find the work of their choice. The teacher might well keep in mind when making such studies the opportunities of pointing out the characteristics of some of the occupations to the students.

The concientious chemistry teacher, vitally interested in his job and in the future welfare of his pupils, will not pass up the opportunity to be of service in assisting them to find their places in the sunlight of happiness and contentment rather than in the shadow of discontent and failure.

MAGNESIUM AND MANGANESE

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A confusion exists in the minds of many students regarding the compounds of magnesium and manganese. The history of these two elements reveals that this uncertainty is not new, but that the names applied to their minerals and compounds were ambiguous to all chemists from the time of their discovery until both the metals were isolated over a century ago.

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Many chemistry teachers often have occasion to be impatient, not only with a student in an elementary course, but also at times with a senior major who confuses the symbol Mg with the element manganese. In the majority of beginning courses a student encounters a compound of manganese before one of magnesium since pyrolusite, manganese dioxide, is employed in one of the first experiments, the preparation of oxygen. A student is often already familiar with the term "magnesia" because of certain well-known medical preparations. When manganese is encountered there is a tendency to confuse it with magnesia merely from the similarity in sound. The symbol Mg is naturally associated with magnesia so it will also suffice equally well for manganese unless a rigid distinction has been made.

The history of the two elements, manganese and magnesium, and the derivation of their names show that a confusion existed between them universally until the first part of the 19th century. "The New English Dictionary" (*1*), "The Encyclopedia Britannica" (*2*), and Mellor's "Comprehensive Treatise on Inorganic and Theoretical Chemistry" (*3*) shed some interesting light on the origin of the confusion.

It is most generally believed that a manganese compound was known before any of the compounds of magnesium. According to Pliny (A.D. 23–79) the Egyptians and Romans used a substance he called *magnes* for bleaching glass. This was probably pyrolusite for analysis of such glass has shown that it often contains as much as two per cent manganese oxide. In fact, the word pyrolusite is derived from the Greek words meaning "wash by fire." The term *magnes* as used by Pliny was, however, very ambiguous since he described several different kinds of *magnes*. This raises the question of the derivation of this word. Euripides (480–406 B.C.) gave the name *magnetis lithos* or *magnes* to a mineral found in Asia Minor, which had the property of attracting iron. This mineral is known to us as lodestone, magnetite, or magnetic oxide of iron. It seems that the phenomenon of magnetism was known to the Greeks and Romans for many years, the properties of the lodestone being mentioned by Thales (7th–6th centuries B.C.). Lucretius (96–55 B.C.) states that the mineral *magnes* took its name from its parent district in Asia Minor, Magnesia. On the other hand, there is a story that a shepherd, Magnes

by name, discovered the mineral when he noticed that his iron staff and shoes containing iron nails became much heavier than usual as he walked over certain ground. This is supposed to have happened while he was tending his flock on Mt. Ida. The country as well as the mineral, according to this tale, took its name from the shepherd.

Probably Pliny's only justification for associating pyrolusite with lodestone was its physical appearance. Since pyrolusite does not possess the power of attracting iron he postulated a feminine gender to explain its weakness. This variety of *magnes* became known as *magnesia nigra* while the lodestone was called *magnesius lapis* in addition to the general term *magnes*. Dioscorides (1st century) added another term when he referred to *magnesia nigra* as *magnes lithos*. A third variety of *magnes* was called simply *magnesia*. This material was associated with the lodestone merely because it also was found in Magnesia. This was a white mineral and like pyrolusite in having no magnetic properties. It is believed to have been a variety of talc.

The term "magnesia" was applied by the alchemists to denote some property of matter such as whiteness or brightness. This was probably no more confusing nor ambiguous than the other uses of the word.

History tells us that the first compound of magnesium to be discovered was Epsom Salt, hydrated magnesium sulfate. This was found by Grew in 1695 in the mineral water from the springs of Epsom. Its chemical nature was not known until the work of Black in 1755. A few years after the discovery of Epsom Salt a white powdery substance called *magnesia alba* was prepared by Count di Palma of Rome. This was a basic magnesium carbonate and got the name *magnesia alba* possibly because of its contrast in color to *magnesia nigra*. *Magnesia alba* was reputed to possess remarkable medicinal properties and its preparation remained a secret for several years.

Thus two substances of entirely different chemical nature came to be known by closely related names. The term "magnesia" in many scientific books of the 18th century refers to the oxide of manganese. The chemists until the first part of the 18th century regarded *magnesia nigra* or pyrolusite as an ore of iron, but an impure one because it would yield no iron. Investigations by Pott in 1740, Scheele in 1774, and by T. Bergman in the same year revealed the true nature of the mineral. It was Bergman who reduced this substance with charcoal and obtained the elementary metal. This metal now known to us as manganese was called at that time "magnesium" and also "manganesium," the latter term having been derived from "manganese," which is probably an Italian corrupted form of magnesia. The word manganese occurs in the writings of Albertus Magnus (1206–1280). Besides this variation this man is credited with the following names for the magnet: *magnesia*, *magnasia*, *magnosia*,

mangadesum, and *manganensis*. After Count di Palma's powder appeared it was the best practice among the French, English, and Italian chemists to refer to *magnesia nigra* as "manganes" and to confine "magnesia" to *magnesia alba*.

The chemical nature of Epsom Salt and magnesia was fairly well determined, as mentioned above, by Black in 1755. It is possible that the element known today as magnesium was first isolated by Le Sage in 1777, since it is reported he obtained small metallic particles by igniting Epsom Salt with potash and charcoal. The isolation of the element, however, is generally attributed to Davy, who obtained the metal in a more or less impure form by electrolysis in 1808. Davy named the element "magnium" although he believed "magnesium" was more appropriate. His opinion is shown in the following words: "magnium is undoubtedly objectionable, but magnesium is employed by T. Bergman for metallic manganese, and would consequently have been an equivocal term." Since "manganesium" was also used for manganese this element had more than its share of names. To avoid possible ambiguity some chemists referred to Davy's metal as "talcium." The question was soon settled in 1808 by a decision to apply "magnesium" to the element of *magnesia alba* and "manganese" to the element of *magnesia nigra*.

In conclusion let us point out how curious it is that the names of two elements, magnesium and manganese, with no chemical similarity have been derived from *magnes*, the name of a substance with no relation to either.

Glossary

Name	*Origin*	*Designating*	*Used by*
Magnes	Greek	Lodestone	Euripides, Pliny
	and Latin	Pyrolusite	Pliny
Magnesia nigra	Latin	Pyrolusite	Pliny
Magnesius lapis	Latin	Lodestone	Pliny
Magnetis lithos	Greek	Lodestone	Euripides
Magnes lithos	Greek	Pyrolusite	Dioscorides
Magnesia	Latin	Talc	Pliny
		Brightness	Alchemists
		Magnet	Albertus Magnus
		Basic magnesium carbonate	18th century chemists
		Magnesium oxide	19th and 20th centuries chemists
Magnesia alba	Latin	Basic magnesium carbonate	di Palma
"Manganese" or "manganes"	Italian	Pyrolusite	Albertus Magnus and chemists of the 18th century
"Magnesium" and "manganesium"		Metal from pyrolusite	T. Bergman
"Magnium"		Metal from *magnesia alba*	Davy
"Talcium"		Metal from *magnesia alba*	A few chemists in 1808

The preceding glossary should help prevent this article from adding any more confusion in regard to these two elements.

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(1) "The New English Dictionary," Clarendon Press, Oxford, Vol. VI, **1908**, p. 29, 115.
(2) "The Encyclopœdia Britannica," 14th ed., Encyclopœdia Britannica, Inc., New York City, vol. XIV, **1929**, pp. 635, 797.
(3) MELLOR, "Comprehensive Treatise on Inorganic and Theoretical Chemistry," Longmans, Green & Co., London, Vol. IV, **1923**, p. 249.

Language Said to Hinder Study of Personality. Language is one of the things that have stood in the way of a scientific study of human personality, Dr. Mark A. May, of the Institute of Human Relations, Yale University, said in a recent report to the Psychological Corporation.

"We have more scientific facts about the behavior of wasps, bees, frogs, chickens, rats, rabbits, and apes than we have about human behavior, for the reason that animals cannot talk to us. Being unable to communicate with them by language we have been forced to develop technic for close observation of their behavior. When we want to know something about the behavior of a spider we watch its behavior and devise an elaborate system of note-taking for recording our observations systematically.

"But when we want to know about the behavior of our fellowman we either ask him or ask some one else, or give him a test, or get him to answer a questionnaire. I verily believe that if all psychologists were deaf and dumb we would know more about the plain facts of every-day life than we now do.

"But this is not all," Dr. May added. "Language is a further handicap to the progress of science in another way. Ethnologists tell us that the English language was not invented by a committee of scientific men appointed by some royal primitive society. Natural and biological scientists got on to this fact long ago and invented a language of their own drawing heavily on the Latin and Greek. But the psychologists and social scientists still stick to Noah Webster's dictionary. The result is that it is well-nigh impossible to describe human behavior in terms that are precise and unambiguous. . . . .
—*Science Service*

Junior High Pupils Lack Mathematical Concepts. Fewer than two-thirds of the fundamental mathematical concepts necessary for the solution of problems in mathematics are understood by the average child when he finishes the Junior High School, it was revealed by a study reported by Charles H. Butler, of the University of Missouri, to a recent meeting in Cleveland of the American Association for the Advancement of Science.

Concepts dealing with money, and others on certain geometric forms, were most readily understood, Mr. Butler found when he tested a large number of children in the seventh, eighth, and ninth grades. Seventy-five per cent of the pupils in each grade have mastered volume, circle, taxation, profit, triangle, and length. Only about two per cent of all the eighth-grade pupils knew what the root of a number is, however.

Prof. Butler was surprised to discover that the largest schools with their greater outlay of money for tuition did not show up as well in respect to this type of mathematical instruction as did the small schools in rural communities.—*Science Service*

APPLICATIONS OF THE SMALL CAMERA

A. G. Moseley, Jr., Marshall College, Huntington, West Virginia

Lantern slides are a valuable aid to teaching, especially when the slides are home-made and the subjects well chosen.

Ways are shown by which the small camera may be applied to the making of lantern slides. A method is described for making microphotographs by use of the small camera.

. . . . . .

In many schools the purchase of expensive photographic equipment is impossible. However, the uses to which photography, in its various phases, may be put are already well known and appreciated. The accompanying suggestions are for those who would like to use photography in their work but feel that they cannot do so from a financial viewpoint. The work proves very interesting and may take the form of a hobby as well as being of value. In many cases a good student may be allowed to do the work as a special assignment.

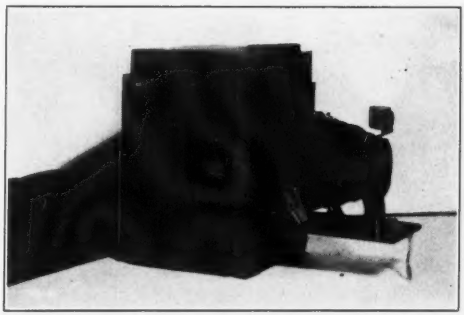

Figure 1

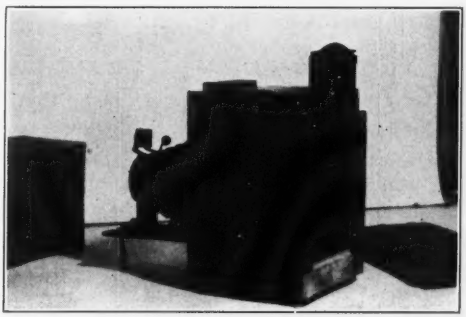

Figure 2
Front and Rear Views of Suggested Arrangement of Camera and Box

The lack of experience in photographic work need be no deterrent, for the person who is able to follow directions and possesses a reasonable amount of manipulative skill can secure good results. The author had no previous experience in microscopic work and very little in photography, yet he has obtained a number of good slides with a very small percentage of failures.

The material contained in the suggestions below may not be entirely original, but is offered for the value it may have. The author has found

FIGURE 3.—SAMPLE PICTURE MADE BY CAMERA SHOWN IN FIGURES 1 AND 2

work of this kind to be very interesting and well worth the cost and effort, both as a hobby and as an investment toward better teaching. Those who are unacquainted with photography will find that working directions for general procedures are easily mastered.

Lantern Slide Making

The making of a lantern slide is essentially the same as producing a photographic print, the difference being that the positive image is placed on glass instead of on paper. Slides may be produced from any suitable negative by direct contact printing if the negative is of the proper size. The primary object here is to explain the use of the small camera in obtaining suitable negatives for the making of slides. For slides of scenes and distant objects the camera may be used as usual, the slides being printed from the resulting negatives. However, often it is desirable to copy some small object, such as a flower, insect, or a small drawing or diagram of a process from a paper. In this case, the average small camera will not produce a sharp image at such close range. Short focus attachments are on sale but even these at times do not permit of close enough focusing. This trouble may be overcome by using the small camera fitted into a box which will have the effect of lengthening the bellows and therefore permitting a shorter focusing range. An ordinary wooden box may be built, about half as deep as the length of the camera bellows. The front of the camera, with film holding back removed, is fitted into the

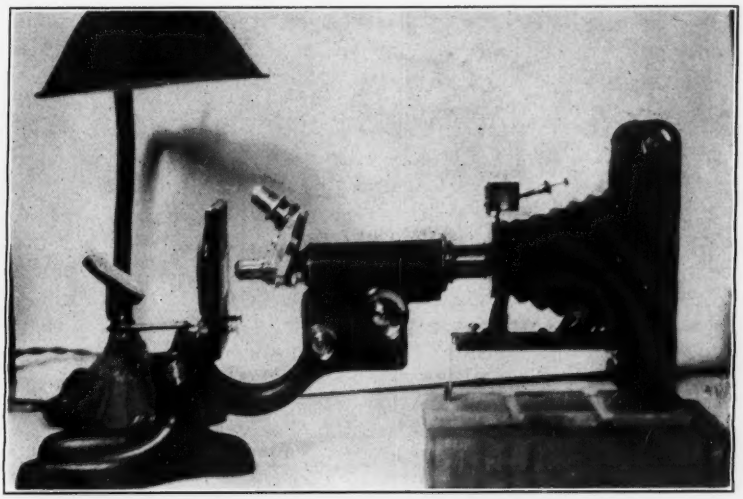

FIGURE 4.—ARRANGEMENT OF CAMERA AND MICROSCOPE FOR MAKING MICROPHOTOGRAPHS

front of the box and in the back is fitted a holder for a lantern slide plate. This holder may be bought for very little from a dealer. Of course any other sort of negative holder could be adapted to the use, but lantern slide plates make good negatives since they are of the correct size for direct printing of positives. To make a picture, the subject is arranged, properly illuminated, and the focusing done by placing a sheet of ground glass in the back of the box in place of the plate holder, the focusing then being done by extending or closing the bellows of the camera. The plate holder is then replaced and the exposure made. Good illumination can be obtained by the use of two bulbs, one on either side of the camera and directed toward the subject. The time of exposure will depend on distance and degree of illumination and will be found by experience. Using two 300-watt bulbs for copying printed matter, the exposure will be in the neighborhood of five to fifteen seconds. Figures 1 and 2 show front and rear views of the arrangement suggested. This box is rather crude and can no doubt be improved upon, especially if it could be made flexible to permit of changing the depth. A sample picture made by means of the camera as shown is given in Figure 3.

The development and fixing of the negatives will need to be done in a dark room of course, or the work may be done at night. Instructions as to development formulas and other helpful material may be obtained from the Eastman Kodak Co. free of charge. Their booklet on "Lantern

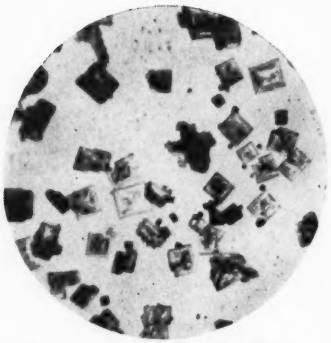

FIGURE 5.—POTASSIUM IODIDE CRYSTALS

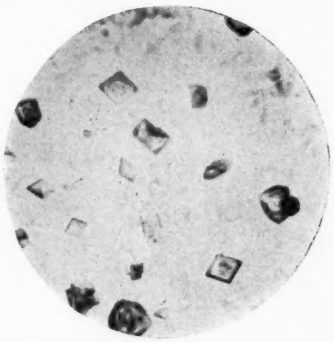

FIGURE 6.—SODIUM NITRATE CRYSTALS

Slides, How to Make and Color Them" is very helpful. This gives instructions for the printing of the slides from the negatives. If the negative to be used is larger than lantern slide size, a print may be made and then copied or the negative may be illuminated and photographed by the arrangement described, the result being the positive desired. A convenient method of illuminating a negative is to place it in front of a sheet of ground glass or parchment paper which is illuminated from behind. There is no doubt that many home-made slides have a value greater than those bought from a dealer, whereas some can be obtained which could not be bought. The cost is much less also. The author has produced slides by the above method at a cost of approximately fifteen to twenty cents each, including the cover glass, binders, and chemicals. The camera used in the above work was a Hawkeye No. 2A with single lens. Any type which has a bellows which can be moved back and forth

FIGURE 7.—SODIUM CHLORIDE CRYSTALS

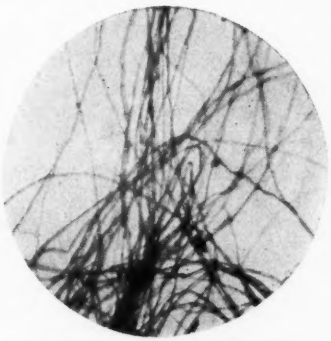

FIGURE 8.—COTTON FIBERS

would serve as well. Often a good focusing camera may be bought very cheaply from second-hand dealers.

Microphotography

In making up some slides for class use it was thought desirable to have some microphotographs of crystals, fibers, and other subjects. Upon experimenting with the idea it was found that when the microscope is in focus for the eye, the fixed focus camera is also in focus if placed with the lens against the eyepiece of the microscope. The accompanying photograph, Figure 4, shows the arrangement used. If there is doubt about the focus being correct it may be checked by removing the back of the camera and substituting a piece of ground glass, upon which the image will show. For illumination of the sample, an ordinary 60-watt electric bulb was used. The accompanying prints (Figures 5, 6, 7, and 8) show crystals of potassium iodide, sodium nitrate, and sodium chloride, and fibers of cotton, respectively. These photographs were made on roll film in the kodak and required about a fifteen-second exposure using a 60-watt bulb. The negatives were then used for printing lantern slides. In order to obtain the crystals for photography, drops of the very dilute solutions were placed on glass plates and allowed to evaporate very slowly. Many other interesting subjects for microphotography will suggest themselves.

Talkies Become New Aid to Teachers. Specialists of the U. S. Office of Education, in Washington, have been the first to receive a demonstration of a new means for bringing the school teacher into closer contact with the experts of her field—a special series of talking pictures designed for parent and teacher guidance.

The series will be shown for the first time during the coming months to a specially invited group of educators in Washington. It has been prepared by the educational department of Electrical Research Products, Inc.

One talkie of the series deals with the creative approach to education, the "star" lecturer being Dr. Hughes Mearns, of New York University. Dr. Arnold Gesell takes the audience through his laboratory at the Clinic for Child Development at Yale University, and they are able to see the babies being tested there while listening to the psychologist's discussion of the value and purpose of the work. Another film on child psychology features Dr. Charlotte Bühler, and demonstrates her tests of the mental development of infants during the first year. Still another is contributed by Mrs. Ina Craig Sartorius of the Horace Mann School, New York.

The Commissioner of Education, Dr. William John Cooper, takes part in a film in which he shows some of the best methods for teaching civics, government activities, and current events. And there are others in the series dealing with special methods for teaching other particular subjects.

With the demonstration of this series at the Office of Education, officials were also shown educational talking pictures especially adapted for use in the classroom. Portable equipment, which can be taken from school to school in a few specially made trunks, was used for the projection.—*Science Service*

A MODEL WATER SOFTENER FOR CLASSROOM DEMONSTRATION

AUGUST EHMKE, JR., WILLIAM CHRISMAN HIGH SCHOOL, INDEPENDENCE, MISSOURI

A demonstration apparatus illustrating the zeolite or "green sand" process for softening hard water is described. This demonstration affords an opportunity, not only to acquaint the student with one of the practical applications of chemistry, but to emphasize the law of mass action.

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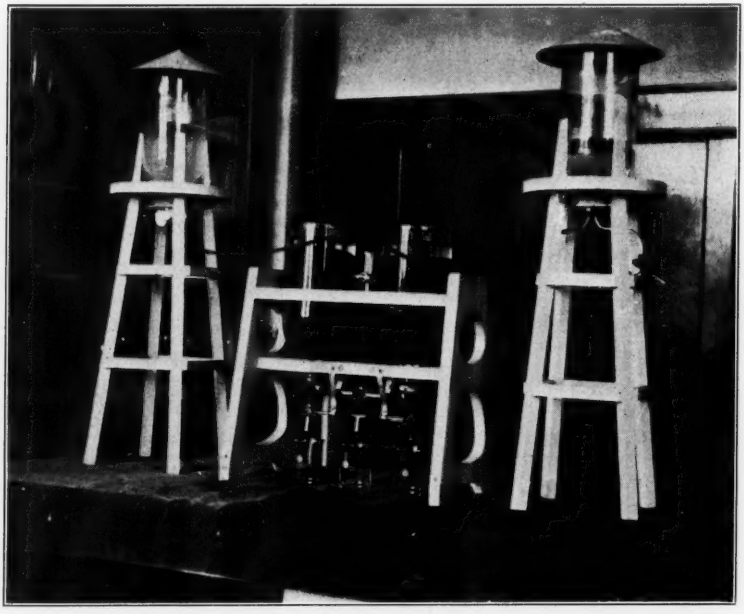
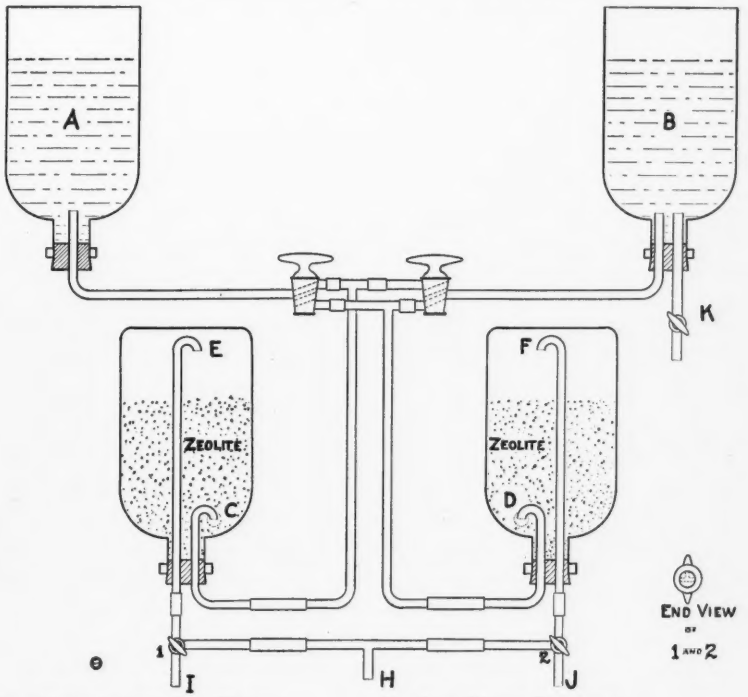
In the opinion of the writer one of the important objectives of the instructor in high-school chemistry should be to relate the science of class-



room and textbook to the activities of the workaday world. In this particular locality there is a wide range of industries which make use of chemical processes, and classes are cordially received. In some cases, however, where the industry is not of such nature as to necessitate the maintenance of a chemical laboratory, chemical processes are conducted by rule-of-thumb methods and there is little knowledge of the science underlying them. In such cases the instructor must supplement the information acquired by the class in the course of an inspection trip with explanatory details imparted in the classroom. The apparatus here described was devised for such a purpose.

Construction and Operation

The accompanying photograph and drawing reveal all the essential details of construction. The vessels which serve as containers for salt water (*A*) and hard water (*B*) and for the zeolite filters (*E*) and (*F*) are ordinary laboratory acid bottles. The bottoms have been removed from



A—CONTAINER FOR SALT WATER
B—CONTAINER FOR HARD WATER
C AND D—INLETS FOR HARD WATER (AND FOR SALT WATER WHEN REGENERATING). THESE ARE PROTECTED WITH BRASS SCREEN
E AND F—OUTLET DRAINS FOR SOFT WATER
H—SOFT-WATER DELIVERY
I AND J—DRAINS FOR WATER WHEN REVIVING SPENT ZEOLITE
K—DRAIN TO SUPPLY HARD WATER FOR TEST
1 AND 2—STOPCOCKS

the former two. This may be done by first chilling the bottles and then quickly pouring in enough boiling water to cover the bottoms completely, taking care that it does not splash upon the sides. When the bottles are lifted the bottoms will drop out. Sharp edges may then be dressed with a file.

The zeolite containers are filled to about two-thirds of their volume

with zeolite. The openings of the tubes (*C* and *D*) which serve as inlets into these bottles should be protected with brass screening to prevent clogging. The apparatus shown in the photograph permits switching the flow of hard water from the first softener to the second when the former has "gone hard." However, operation must be suspended when regeneration of one or both softeners becomes necessary. A slight modification in connections (shown in the diagram) makes it possible to revive either softener while the other is in operation.

For the reviving fluid we have found it best to use a *saturated* brine solution. This is best prepared in advance by allowing concentrated salt solution to stand for several days in contact with excess solid salt.

A rapid, easily visible test for hardness is desirable for demonstration use. For this purpose the writer has found soap solution satisfactory. A little hard water drawn at *K* curdles the soap; soft water drawn at *H* does not. This simple test also serves to indicate the eventual exhaustion of the zeolite and its subsequent revival.

The time necessary to complete the exchange of metals which is the essential feature of this process will vary according to the "hardness" of the water and the amount of sand employed. Rates of flow should be adjusted accordingly.

Pedagogical Considerations

The instructor may employ this demonstration, not only as an explanation of one of the every-day applications of chemistry, but as an occasion for stressing or reviewing the law of mass action and the characteristics of reversible reactions in general.

Geologist Believes U. S. Could Produce Radium at Foreign Price. It would be possible for the U. S. Bureau of Mines to manufacture one gram of radium from vanadium-uranium-radium ores in Colorado and Utah at a cost comparable to the price for which radium can be purchased from the Belgian Congo. Dr. G. F. Loughlin of the Geological Survey has made a survey of the mines in these states and has reported to the House Committee on Mines and Mining.

In the mines in question, uranium used to be the product sought, but the ores are worked chiefly today for vanadium. Uranium and radium could be extracted from the vanadium ores as by-products, so that the chief cost of mining and exploration could be borne by the vanadium production. Dr. Loughlin suggests the addition of uranium units to existing vanadium plants, or the building of new mills for the extraction of both vanadium and uranium. Of late years uranium has been mined only by gouging out small quantities to sell to manufacturers of radium belts and radioactive waters.

Although warning that his estimate is only a guess, Dr. Loughlin says he believes that radium could be extracted from these ores at a cost of $50 a milligram. The price of radium from the Belgian Congo is now about $60,000 per gram.—*Science Service*

SOLVING THE HYDROGEN SULFIDE PROBLEM

SIDNEY J. FRENCH, FRANKLIN COLLEGE, FRANKLIN, INDIANA

The generator recommended below has been found to be very practical in operation. It permits little gas to escape into the room, develops no excess back pressure, is easy to charge and recharge, is simple and convenient to operate, can be constructed by the student from inexpensive materials, and can be used for the generation of other gases. It has effectively solved the awkward problem of an adequate, convenient and ready source of hydrogen sulfide for the individual student.

. . . . . .

The problem of a suitable source of hydrogen sulfide for use in qualitative analysis is still a live one in many schools. It is especially alive in the smaller institutions where the installation of permanent equipment is uneconomical. Kipp generators are far from satisfactory but seem to be the lesser evil. They have the bad habit of "running down" at the most crucial moments and the unfortunate students must wait while the assistant in charge performs the disagreeable and tedious task of recharging. Ferrous sulfide often slips through into the bottom chamber and through its reaction with the acid present sets up a back pressure of gas which sooner or later results in the escape of gas through the reservoir tube. The writer recently visited a college where the Kipp generator had just been thrown out of the laboratory window by an irate and disgusted professor.

Feeling that both portable tank gas and paraffin-sulfur combinations were unsatisfactory sources of hydrogen sulfide for various reasons, an attempt was made to develop a generator which could be constructed by the student, and one which would eliminate the disadvantages of the Kipp, give an adequate gas supply and pressure, and be reasonable in cost. The writer is indebted to two of his students, Mr. Ralph Mozingo and Mr. Earl McClelland, for working out his suggestions. The generator described below was finally adopted as the most suitable. It is now in constant use in the qualitative analysis laboratory where it is giving excellent results. Each student constructs his own generator at the beginning of the course, keeps it in his desk, and uses it under the hood. The making of the generator itself is an interesting and valuable lesson in glass manipulation, though not too difficult for the average student. It is well to have the student save all of his old test tubes with broken bottoms, or the supply of good tubes will be rapidly depleted during the experimental work on glass manipulation.

The Generator

A test tube is heated, drawn out, and bent so as to provide an elbow in the middle. (See Figure 1, *A*.) The bottom of the tube may be sealed off and blown out into a bell if desired. Necessarily, the tube must be inserted in the rubber stopper (of proper size to fit a wide-mouth bottle)

before the bending is done. The stopper should carry two other holes of size to fit ordinary glass tubing. A second test tube is heated near the bottom and is drawn out to give a tip of sufficient length to reach to the bottom of the bottle when the tube is thrust through the stopper. (See Figure 1, *B*.) The third hole carries a short bent glass tube connected by a bead valve to a second short glass tube having a fire-polished end. This serves as a mouthpiece.

Figure 1 shows the assembled generator. The delivery tube, *C*, is an ordinary glass tube of rather large bore drawn out and closed at the outer end by a bead valve, *D*, into which a delivery tip can be inserted. The top of tube, *C*, should be somewhat above the average level of the liquid in *B* to prevent acid from being carried over by the gas into the solution being tested. The large bore of the delivery tube also aids in preventing this. Before stopper *E* is inserted, a loose plug of glass wool, *H*, is thrust down into the bend of tube, *A*, and a short stick of ferrous sulfide, *G*, is placed above it. Since the surface of the ferrous sulfide exposed to action is rather small, it is advisable to use acid of somewhat greater concentration than is usually used in a Kipp.

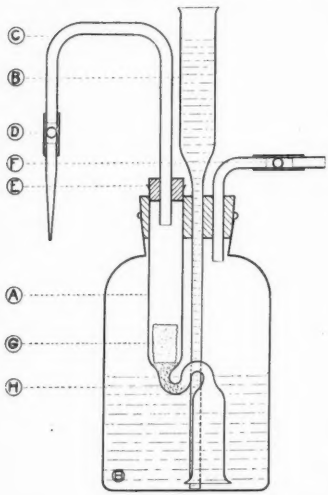


FIGURE 1

When the apparatus is assembled, acid is added through *B* while valve *F* is held open. The amount of acid solution used is immaterial so long as it covers the bottoms of tubes *A* and *B*. When sufficient acid has been added, valve *F* is closed while tube *B* is filled to within an inch of the top. Valve *D* is then opened until the acid rises in *A* above the level of the ferrous sulfide. The valve is then closed and the levels allowed to readjust themselves. More acid is added to *B* to bring the level of the solution again to within an inch of the top.

By regulating valve *D* properly in operation, so that the acid in *A* just covers the ferrous sulfide, a slow steady stream of gas under sufficient pressure is obtained. It has been found in most cases that the level of the acid reservoir in *B* gradually falls over a period of days or hours when the generator is not in use. The level is quickly and easily reestablished by blowing gently through valve *F* till the solution rises to the proper height in *B*. To empty the spent acid from the generator, it is only necessary to remove valve *D* and connect in its place a long tube reaching

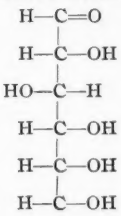
below the bottom of tube *A*. Blowing through the valve *F* starts the siphon action which continues as long as valve *F* is kept open. Fresh concentrated acid can be added through *B* while valve *F* is open. If particles of ferrous sulfide are carried through the glass wool plug and over the elbow into the lower reservoir (which happens very seldom), the back pressure created by their reaction with the acid can be quickly relieved by opening valve *F* for an instant.

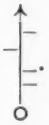
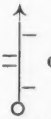
A NUMBER SYSTEM FOR SUGAR CONFIGURATIONS

LOUIS SATTLER, BROOKLYN COLLEGE, BROOKLYN, NEW YORK

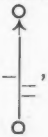
The use of symbols for representing the configurations of sugars has been suggested by a number of writers. The following method has been found to be an excellent aid to the memory. It is applicable to the systems suggested by others.

For example, if we represent C=O or HC=O group by an arrowhead ↑, the straight carbon chain by a vertical line, the hydroxyl groups by short horizontal bars, and the H_2COH group by small circles, glucose



may then be pictured as  . If we adopt the convention of writing the aldehyde group on top and then count the number of hydroxyl groups occuring together on one side before we come to the hydroxyl groups on the other, we find for glucose 1-1 and then 2. For mannose it is 2-2, and for galactose  or 1-2-1.

Hence, we can recall very readily the configuration of glucose by merely remembering the number 112, of mannose by 22, of galactose by 121.

This mnemonic method may be readily extended to other sugar types. Fructose, for example, would be  , its mnemonic 12′, the prime representing the CH_2OHCO group.

A CHANGEABLE CARBOHYDRATE MOLECULE

C. W. Eddy, 148 S. Mission Road, Los Angeles, California

The changeable carbohydrate molecule here presented illustrates one hundred ten structures of the common sugars and their derivatives. The model is based on the "slide-rule" principle and the different structures can be changed easily and rapidly to illustrate the usual carbohydrate reactions. The author hopes that with the presentation of the "molecule" and a previous chart (1) the use of charts and models may come to form a larger part of the teaching of chemistry in general.

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With the ever-increasing amount of knowledge that is accumulating in a given field it becomes necessary to find some new methods that will elimi-

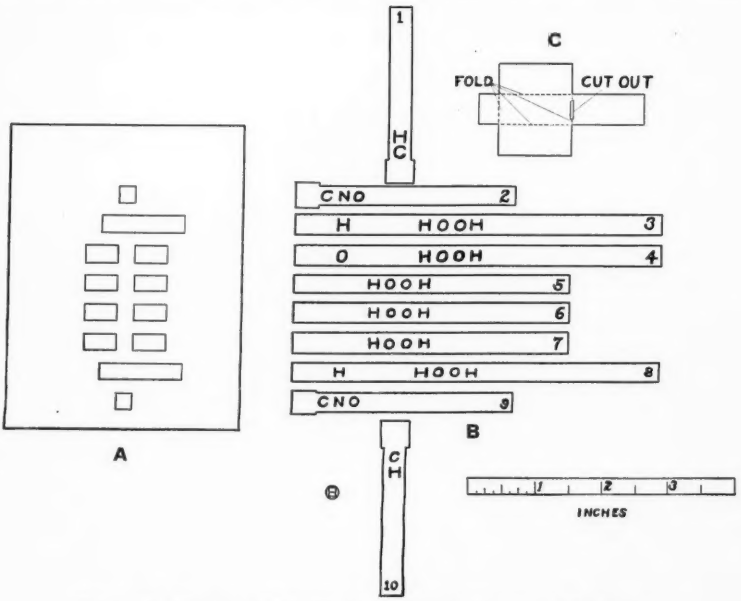

Figure 1.—Showing Essentials of Construction of Molecule

nate some of the unnecessary steps in the teaching of the particular subject and yet cover the essential material in a clear and understanding manner for the student. During the recent years much thought and time has been given to the presentation of a subject by means of charts, models, and other objects which aid the student through his sense of sight to comprehend more clearly the material and to fix it more firmly in his mind. Outside the use of the periodic table charts and a few charts for typical or general reac-

tions in inorganic and organic chemistry, the use of charts has been somewhat limited.

The "molecule," as it is called, herewith presented is intended to stimulate the interest in and at the same time elucidate more clearly the fundamental relations that exist between the sugars (especially the pentoses, the hexoses and some of their derivatives) by the use of an arrangement which, by means of a few simple movements, shows the structure of over one hundred of the carbohydrates and their derivatives.

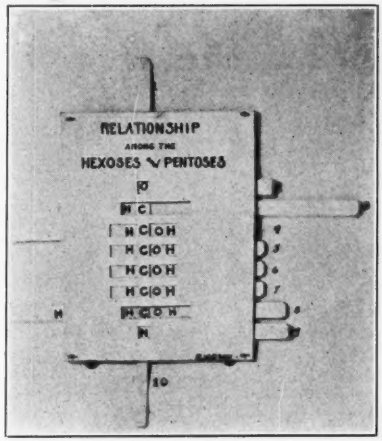

FIGURE 2.—*d*-ALLOSE

In a recent article (*1*) the author has presented a chart of the relations existing between the carbohydrates along with an explanation of the reactions that enable one to pass from one of the sugars to another. The present article is to supplement the chart and give the student a clearer conception of the structure of the carbohydrates and the close relations that exist between them.

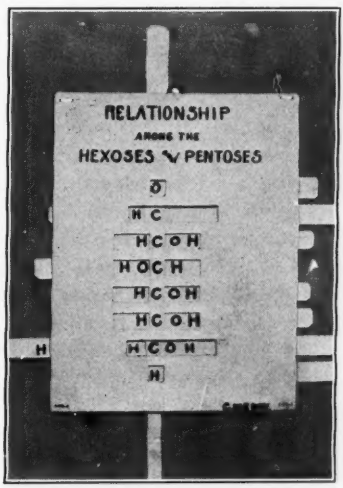

FIGURE 3.—*d*-GLUCOSE

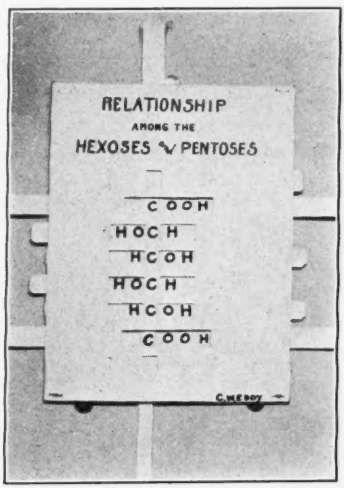

FIGURE 4.—DIBASIC ACID OF *d*-IDOSE

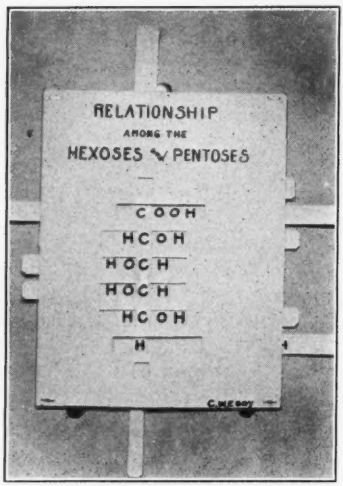

FIGURE 5.—MONOBASIC ACID OF *l*-ARABINOSE

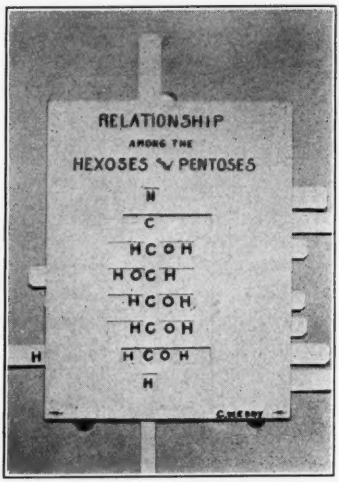

FIGURE 6.—NITRILE OF *d*-GLUCOSE

The principle upon which the molecule works is not a new one. The application to which it is put is new; that of showing the various structures of the carbohydrates and some of their derivatives by the use of the "sliding-rule strips," thereby eliminating the necessity of writing the structures. The making of such a molecule would make an excellent problem in a course of organic or carbohydrate chemistry. It would give the student a clearer conception of the structure and reactions of the sugars than could be obtained in any other way. The use of a large one (a yard square) in the lecture room would aid not only in the presentation of the subject, but would enable the student to visualize the changes that occur during the usual reactions.

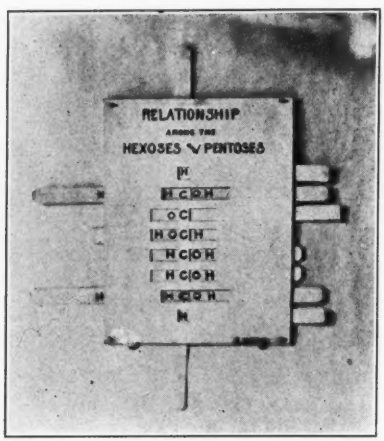

FIGURE 7.—*d*-FRUCTOSE

Figure 1 shows the essential details of the molecule; (*A*) the blank, (*B*) the strips, and (*C*) the pockets. The size of the molecule can be adjusted to meet

the individual requirements; the author's was made of three-ply white cardboard, $7'' \times 9''$, with strips $^{9}/_{16}''$ wide and approximately the lengths shown in Figure 1 (*B*). In order to place the symbols in the most desirable locations on the various strips, it is suggested that the strips be cut out and slipped into their respective places, and the symbols printed. Strips 1, 2, 9, and 10 are made to slide into pockets, which are made from heavy paper (see Figure 1,*B*) fastened in position on the reverse side of the molecule. When the strips are all in place and lettered, a piece of cardboard the size of the front of the molecule can be pasted or fastened to the back. This will not only serve as a protecting back but will give the molecule a neater appearance.

If a large molecule is desired for lecture-room purposes it could be made from plywood or wall board with tin slots for the strips to slide in. If two molecules are used and hung some distance apart, one for the reacting sugar and one for the sugar produced with the proper symbols for the reaction written on the blackboard, there is presented to the student an object lesson not soon forgotten. To *see* the changes which take place during the reaction is to fix it more firmly in the mind and through the use of structural molecules this is made possible.

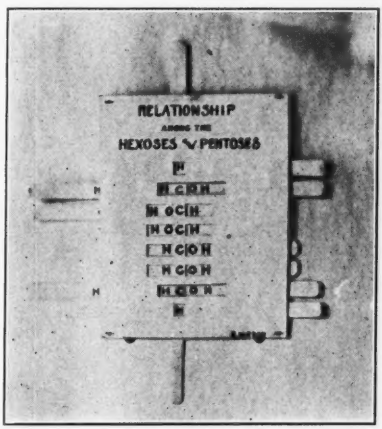

FIGURE 8.—MANNITOL

The accompanying photographs show a number of the structures possible to illustrate by changing the strips of the molecule. By the correct manipulation of the strips it is possible to show the structure of one hundred ten sugars or their derivatives. The following sugars are ones which the author has demonstrated with the molecule: 16 hexoses (8 *d*-forms and 8 *l*-forms), 16 monobasic hexonic acids, 16 dibasic hexonic acids, 16 hexo-nitrils, 8 pentoses, 8 monobasic pentonic acids, 8 pentanitrils, 8 hexanols, 4 pentanols, 4 keto-hexoses, 4 tetroses, and 2 keto-pentoses.

It is hoped with the presentation of the semi-automatic carbohydrate molecule that the studying and teaching of carbohydrate chemistry may be facilitated, and that charts and structural models may come to have a greater part in the scientific study and teaching of chemistry.

Literature Cited

(*1*) EDDY, "A New Relationship Chart of the Carbohydrates," J. CHEM. EDUC., **7**. 2692–6 (Nov., 1930).

THE SEVENTH CENSUS OF GRADUATE RESEARCH STUDENTS IN CHEMISTRY, 1930

CLARENCE J. WEST AND CALLIE HULL, RESEARCH INFORMATION SERVICE, NATIONAL RESEARCH COUNCIL, WASHINGTON, D. C.

The Seventh Census of Graduate Research Students in Chemistry, 1930, continues the annual compilation which was first issued in 1924.* It is interesting to note the steady growth in the number of students in American universities who are undertaking research in the various fields of chemistry: 1700 in 1924, 1763 in 1925, 1882 in 1926, 1934 in 1927, 2071 in 1928, 2498 in 1929, and 2795 in 1930. The present compilation includes returns from one hundred thirty-seven universities, of which twenty-one have reported members of the faculty only engaged in chemical research.

TABLE II

Number of Graduate Students Engaged in Research in Various Fields of Chemistry

	1930									
Subject	*Total*	*M*	*D*	*F*	1929 *Total*	1928 *Total*	1927 *Total*	1926 *Total*	1925 *Total*	1924 *Total*
General and Physical	520	208	312	261	448	406	430	343	332	240
Colloid	78	39	39	32	82	86	79	58	77	69
Catalysis	44	21	23	20	34	27	28	31	33	51
Subatomic and Radio	39	10	29	23	20	18	21	21	27	20
Electro-Inorganic	49	26	23	15	24	25	21	32	42	38
Electro-Organic	19	8	11	11	15	13	11	13	14	18
Photochemistry and Photography	44	10	34	19	41	22	25	25	19	24
Inorganic	129	73	56	69	116	124	116	109	86	101
Analytical	102	53	49	79	95	96	75	54	44	71
Metallurgical	46	35	11	32	36	22	21	34	28	38
Organic	811	379	432	312	719	668	570	475	430	422
Physiological	233	113	120	193	222	146	134	207	196	172
Pharmacological	16	8	8	18	14	11	7	14	20	30
Pharmaceutical	34	13	21	25	27	16	14	21	39	20
Sanitary	16	10	6	13	27	30	25	11	12	9
Nutrition	78	41	37	65	80	52	58	51	76	48
Food	34	19	15	16	31	52	27	37	49	35
Agricultural	108	54	54	65	91	111	89	72	55	91
Industrial and Engineering	63	40	23	40	91	156	183	274	184	203
Chemical Engineering	301	185	116	96	285	..	..	..	..	..
TOTALS	2795*	1376	1419	1404	2498	2071	1934	1882	1763	1700

* 31 masters in pure chemistry not classified.

* ZANETTI, *Ind. Eng. Chem.*, **16**, 402 (1924); NORRIS, *ibid.*, **17**, 755 (1925); WEST AND HULL, J. CHEM. EDUC., **4**, 909 (July, 1927); **5**, 882 (July, 1928); **6**, 1338 (July-Aug., 1929); **7**, 1674 (July, 1930).

| | | |

TABLE I

Number of Graduate Students Engaged in Research in Chemistry According to University and Subject

"M" indicates those working for a Master's degree, "D," Doctor's degree, and "F," number of faculty engaged in research

Universities by States	General and Physical M D F	Colloids M D F	Catalysis M D F	Subatomic and Radio M D F	Electro-Inorganic M D F	Electro-Organic M D F	Photochemistry and Photography M D F	Inorganic M D F	Analytical M D F	Metallurgical M D F	Organic M D F	Physiological M D F	Pharmacological M D F	Pharmaceutical M D F	Sanitary M D F	Nutrition M D F	Foods M D F	Agricultural M D F	Industrial M D F	Chemical Engineering M D F	TOTAL M D F	Universities by States
Alabama:																						*Alabama:*
Ala. Polytech. Inst.								1 1				2 1								2 4	5 6	Ala. Polytech. Inst.
Birmingham So. Coll.		1																	1 1	1	1 3	Birmingham So. Coll.
Howard College												1										Howard College
Univ. of Alabama	4 1		2 1	1					1	1	10 1	2 1	1						1 1	2	25 5	Univ. of Alabama
Arizona:																						*Arizona:*
Univ. of Arizona	1 1								1 1		4 2					1 2		6			7 12	Univ. of Arizona
Arkansas:																						*Arkansas:*
Univ. of Arkansas									1 1		2	4			2 1	1		1 2	1		5 11	Univ. of Arkansas
California:																						*California:*
Calif. Inst. Tech.	13 8			4 4			2 2	1	1		2 2 2	2 2				1 1				5 1	7 23 21	Calif. Inst. Tech.
Claremont Colleges*									1		2 1										3 3	Claremont Colleges*
Mills College												1 1									1 1	Mills College
Stanford Univ.	5 7 5	2 2		1 1	1	1	1 7 1				14 3 2	4 3 3						1			25 25 14	Stanford Univ.
Colorado:																						*Colorado:*
Colorado College									1		1 2								1		1 2	Colorado College
Univ. of Colorado	8 1 2	1						3 1 1			7 1 2	7 5 3		2 2	2 1		1 1				31 11 9	Univ. of Colorado
Connecticut:																						*Connecticut:*
Conn. Agr. College		1							1		1										3	Conn. Agr. College
Trinity College	1 2		1 2																		2 4	Trinity College
Wesleyan University	1		1					1			3 1				1				1 1		7 3	Wesleyan University
Yale University	9 9						1 1		1		21 21									1 7 2	1 38 34	Yale University
Delaware:																						*Delaware:*
Univ. of Delaware	1										1										1 1	Univ. of Delaware
District of Columbia:																						*District of Columbia:*
American University	1									2	1	1									1 2 2	American University
Catholic University	1										1 2										1 2 1	Catholic University
Geo. Washington U.											2 2 2	2 4									4 2 6	Geo. Washington U.
Georgetown Univ.	1									1	3 3	4 8		4 6	2		1				1 7 25	Georgetown Univ.
Florida:																						*Florida:*
University of Florida	1 1								1 1		2 1 3	1	2 2	1 2						2 1	9 1 11	University of Florida
Georgia:																						*Georgia:*
Wesleyan College	1																				1	Wesleyan College
Hawaii:																						*Hawaii:*
Univ. of Hawaii	1								1		1 3			1		1 1	1 1	2			5 8	Univ. of Hawaii
Idaho:																						*Idaho:*
Univ. of Idaho	2	2									1 1							6 4			7 9	Univ. of Idaho
Illinois:																						*Illinois:*
Illinois Wesleyan	1										1										2	Illinois Wesleyan
Monmouth College											1										3	Monmouth College
Northwestern Univ.	3 4 5	1				1		1			5 12 5	8 6 3							1		18 22 15	Northwestern Univ.
Univ. of Chicago	1 5 1			3 1			8 2	10 7 2			10 36 13	5 7 15					1				26 74 39	Univ. of Chicago
Univ. of Illinois	9 31 7		2	2	2 5 1	1	2	1	1 5 2		26 37 6	6 8 2		1		2 6	3		1	4 5 7	52 97 37	Univ. of Illinois
Indiana:																						*Indiana:*
Indiana University	2 5 2	1	2 4 1		9 2	1		2 1			3 1 1				1				1		20 13 7	Indiana University
Purdue University	1 2 5							3 2 3	2 1		10 1 3	2 3 2								1	17 10 14	Purdue University
Rose Polytech. Inst.	1									1											2	Rose Polytech. Inst.
Univ. of Notre Dame	4 1 1								5 1	1 1 1	3 3 3		1								14 5 6	Univ. of Notre Dame
Iowa:																						*Iowa:*
Grinnell College											1										1	Grinnell College
Iowa State College	5 9 1	1 2 1						3 4 3			15 15 1	1 6 1				4 1 3	2 8 1	4 14 3	3 3 1	5 7 3	43 69 18	Iowa State College
State Univ. of Iowa	6 1 1	2 3 1	1 1		2			6 2 3	1 5 1	2 1	17 9 2	4 7 5	1 1	3	4 1 2	11 10				4 3 1	58 35 31	State Univ. of Iowa
Kansas:																						*Kansas:*
Kansas Agr. Coll.	4 1 3								1 3		2 4	3 2				5 5		4	1	2 1	16 3 23	Kansas Agr. Coll.
Univ. of Kansas	3 5 4	3 1	2		1	1		2	2	2 1	6 4 3						2				20 9 13	Univ. of Kansas
Kentucky:																						*Kentucky:*
Univ. of Louisville	2 1				1				1 1		6 1	1 3				1	1		2		12 9	Univ. of Louisville
Louisiana:																						*Louisiana:*
La. State Univ.	2 2		2		1	1			2 1		5 3							3 1	1	2 1	19 8	La. State Univ.
Tulane					2				1		1 1	3 3									7 5	Tulane
Maine:																						*Maine:*
Bates College											1										1	Bates College
Univ. of Maine	1 1				1				1 1		2 1 2					1	1	2	1 1	1	5 11	Univ. of Maine
Maryland:																						*Maryland:*
Johns Hopkins Univ.	14 5	1 2 2	5 2	1 2		2 3		1	1 2		16 9		1 1			9 1				2 4	1 54 31	Johns Hopkins Univ.
Univ. of Maryland	4 3 2								1		7 2 1						1 1 1	1 1	1		12 7 7	Univ. of Maryland
Massachusetts:																						*Massachusetts:*
Amherst College			1								2										3	Amherst College
Boston College			1								4 1										5 2	Boston College
Clark University	1							1			3 1								1 1		5 3	Clark University
Harvard University	21 13				6		1 2	1	1		2 26 16	1									2 55 32	Harvard University
Holy Cross College	1 1					1			1	1	1 1										3 5	Holy Cross College
Mass. Agr. College		1						1			3 1										5 1	Mass. Agr. College
Mass. Coll. Pharm.														2							3 2	Mass. Coll. Pharm.
Mass. Inst. Technology	15 9							3 5 5	2		7 30 11	1					1		1	49 15 8	59 65 38	Mass. Inst. Technology
Mt. Holyoke College	3 2			1 1			1				1 1										5 5	Mt. Holyoke College
Smith College	1								2 1		3 1	1 1									5 1 4	Smith College
Tufts College	1									1	1 1	2							1		2 6	Tufts College
Wellesley College											2 1	1 2									3 3	Wellesley College
Williams College	1			2 1			1														2 3	Williams College
Worcester Polytech.	1 2				1						1								1	1 1	2 6	Worcester Polytech.
Michigan:																						*Michigan:*
Michigan State Coll.	11	2			1				1		11 3	2 3			1	1		1 1		2	32 8	Michigan State Coll.
Univ. of Michigan	10 3				5 1			1	5 4		5 5	3 7 5		7 2						42 23 12	76† 63 32	Univ. of Michigan
Minnesota:																						*Minnesota:*
Univ. of Minnesota	4 12 6	1 3 3	2 1	6 1	1 2		1	2 1 2	2 1 2		4 12 7	4 4 3	1 2 4			4 1 2		2 5 4	4 3	4 4 3	33 55 42	Univ. of Minnesota
Mississippi:																						*Mississippi:*
Univ. of Mississippi					1				1 1		2 3								1		4 5	Univ. of Mississippi
Missouri:																						*Missouri:*
Mo. School of Mines	1							2	2 1 1	4 3	1									2	8 1 8	Mo. School of Mines
St. Louis Univ.	2				2 1						3 1	5 3									5 5 7	St. Louis Univ.
Univ. of Missouri	1	1 1		2 2 2	1		2		1		4 3	5 3 6	2			1 3 3		2	3 1	1	19 12 17	Univ. of Missouri
Washington Univ.	2 12	2						1	1		4 2 4	3 6 4									11 8 24	Washington Univ.

It should be mentioned that in Table II, while a column is given to the faculty, the numbers given there are not included in the totals, as those numbers refer to the graduate students only, and are comparable with the totals for previous years.

It is hoped that this compilation may be continued until data are available for ten years, at which time an effort may be made to evaluate the statistics, and to interpret the trend in the various fields of chemistry as well as in the universities in which the research is being done.

Atmosphere Influences Life of Books. The right atmosphere is necessary for the health of books as well as of humans.

Too much heat, certain gases, dust, and improper lighting all tend to shorten the lives of volumes on library shelves, recent studies conducted at the Bureau of Standards of the U. S. Department of Commerce have shown.

Cabinets in which the atmospheric conditions can be varied at will are being used in the experiments. Preliminary findings indicate that the drying out effect of heat is an important cause of the aging of paper.

Harmful effects of sulfur gases on paper are now being measured. It is thought that sulfur dioxide of the air is readily absorbed by paper and changed by chemical reaction to sulfuric acid which hastens the process of decomposition.

Sulfur dioxide in the air has been found to be an important factor in the sudden deterioration of clothing in laundries in some communities where industrial plants involve the burning of quantities of soft coal. That sulfur gases may have a similar damaging effect on books in city libraries is suggested by the fact that the sulfur pollution in some industrial centers is known to be equivalent to a downpour of 100 tons or more of sulfuric acid per square mile.

As a means of lengthening the life span of books and documents, the government investigators foresee a day when libraries will scientifically control the atmosphere surrounding their shelves. Regulating the heat and humidity, removing the dust and acid impurities from the air circulated in the library, and minimizing the chemically active light rays permitted to shine on the shelves are suggested improvements for the future.—*Science Service*

New Unit of Atom Needed by Science. Scientists are now on the hunt for a new basic unit weight of matter. Chemists have in the past used the atom of oxygen as the unit of atomic weight, calling it 16.

Dr. F. W. Aston of Trinity College, Cambridge, in a communication to scientists printed in *Nature*, has raised the point that since there are now three known varieties of oxygen atoms, known as isotopes 16, 17, and 18, the actual weight of the average atomic weight of the element oxygen is about 1.25 parts in 10,000 greater than the customary 16 assumed in chemical books.

While chemists might get along with the present standard, Dr. Aston intimates, physicists who compared the weights of individual atoms by means of the mass-spectrograph with an accuracy of 1 in 10,000, need a new and more definite unit.

Among the possible units suggested are: the proton or positive nucleus of the hydrogen atom, the neutral hydrogen atom, one-quarter of the neutral helium atom, one-sixteenth of neutral oxygen atom 16. But none of these proposed units is entirely free from objection.—*Science Service*

AN ANALYSIS OF FRESHMAN COLLEGE CHEMISTRY GRADES WITH REFERENCE TO PREVIOUS STUDY OF CHEMISTRY

GEORGE A. HERRMANN, MARQUETTE UNIVERSITY, MILWAUKEE, WISCONSIN

The study of high-school chemistry is presumed to be an asset to the college chemistry student. The object of this discussion is to point out the relative records made in freshman college chemistry by students who have had and who have not had high-school chemistry.

Five distinct groups have been studied, none of which had been segregated on the basis of prior chemical training in high school. Due cognizance has been taken of the differences in numbers of the two classes of students, in that a factor has been established for each of the five groups. This factor has been used in the final calculations, which, in turn, have been represented graphically in the form of charts, while an average chart has also been included, all of which are intended to answer the question, "Does the study of high-school chemistry influence the student's grade obtained in college chemistry?"

. . . . . .

A person can reasonably expect that the student who has had the advantages of a high-school chemistry course should complete the college chemistry course with greater ease and less effort and we can safely predict that such students are very apt to receive a higher grade than at least most of those students who have not taken chemistry in high school.

As a rule, this is the case, and yet there are exceptions, since there will always be high-school graduates who will do mediocre work in college chemistry in spite of the fact that an excellent high-school course was presented to them, just as we shall always find a certain group of high-school graduates, who have not had the advantages of high-school chemistry, doing excellent work in the college course.

And yet, is not our belief that high-school chemistry is an asset in the study of college chemistry more or less based upon speculation? We naturally expect this to be the case. But, really, is it? The analysis of various groups of freshman college chemistry students to be presented later will tell an interesting story.

It must be borne in mind, however, that when final grades were issued no regard was given to the fact that a student had had, or had not had high-school chemistry. A student's final grade was determined solely on the record that he had made in the college course. In fact, this analysis was made long after the final grades were recorded in the official books.

General Conditions of Study

Some time ago, a questionnaire was prepared and given to the three hundred freshman liberal arts and engineering chemistry students who were in attendance during the second semester of the past year. The

summary of the answers, among other things, shows that we are teaching a body of students of a wide variety of preliminary training, not only from a geographical viewpoint but from a scholastic standpoint as well. Approximately 73% of the combined classes as they were constituted at the time that the questionnaire was issued had high-school chemistry, while approximately 27% had no high-school chemistry training. (The proportion for physics, by the way, was slightly higher—80% yes and 20% no.) About 57% of the students had taken both high-school chemistry and physics; 16% had taken chemistry only; 23.5% had taken physics only; while only 3.5% had neither high-school chemistry nor physics.

Segregation of the class on the basis of the students' previous training would be advantageous, were it not for the fact that numerous conflicts in schedules would make this arrangement a hopeless impossibility. For this reason, we make no separation and freshmen are given one type of lecture only, regardless of previous high-school training.

As it is natural to expect, the majority of the students were residents of the State of Wisconsin, although seventeen other states were represented in the classes canvassed, particularly Michigan, Illinois, Minnesota, and Indiana in the order named.

The population of the various cities represented ranged from one hundred inhabitants to three and one-half million. It is interesting to note that 50% of the students who have not had high-school chemistry came to us from small cities, having a population range of 100 to 5000. On the other hand, the greater percentage of the students who have had high-school chemistry were graduates of Milwaukee high schools, which might be natural to expect, considering the relatively large numbers of students coming to us from them.

The average age of the students in the freshman chemistry class this past year seemed to have been 19.4 years, the youngest of whom was 15 years of age.

Reactions of the High-School Chemistry Group

Let us next consider that phase of the questionnaire which was answered by the students who had completed a course in high-school chemistry. The question: "What other subjects besides chemistry did your high-school chemistry instructor teach?" indicated that the teacher of high-school chemistry is just as likely to be assigned to teach other subjects in addition to chemistry as not, the proportion being 50% in each case. The teaching of physics, general science, and mathematics was the most prevalent, while the teaching of botany, biology, physiology, physical training and coaching, Latin, Greek, French, English, civics, history, bookkeeping, commercial law, and even music engaged at least a part of the attention of 50% of the high-school chemistry teachers.

It might seem that some of these points do not pertain to the subject in question; yet they are being introduced at this time merely to emphasize the fact that the students who enter a university are very likely to have been trained along widely divergent lines and under a variegated range of conditions.

Only one-half of the students who have had high-school chemistry knew the title and author's name of their high-school chemistry text, which may or may not be indicative of the interest gained and the knowledge acquired in their high-school chemistry course. One student went so far as to say that the cover of the text depicted a number of chemical instruments and was compiled by five authors, while the laboratory manual was written by the same five *fellows*. Another student claimed that the title of the textbook read "*FUN*amentals of Chemistry."

The number of lectures varied, ranging from none to four per week, lasting from thirty to fifty-five minutes. Of the students, 70% were *not* required to take lecture notes; 45% claimed that the lectures were descriptive; 22% said they were technical; while 33% said they were both descriptive and technical. From one to four recitations were held per week with a varying duration of fifteen to seventy minutes, while from one to two laboratory periods were scheduled each week, lasting from fifty to one hundred thirty minutes.

Most of the laboratory reports were written in notebook form, while separate sheets and the use of the manual itself were also popular methods of reporting experiments. Some students were given a short *daily* written quiz, while others were required to write a quiz but once in three months. Longer examinations worried some students weekly, while others were immune for a period of three to four months.

Outside reading was required in comparatively few cases, covering such phases of chemical work as projects, talks, chemists and their work, book reports, and special topics. Some stated that these assignments were entirely optional and, when done, were performed merely for extra credit. Term papers were required from approximately one-half of the students.

In answer to the question regarding the facilities of the high-school chemistry department, particularly the equipment, the library accommodations and the rooms, 34% stated that they were excellent; 46%, good; 18%, fair; and only 2%, poor.

Lecture demonstrations were used in many cases, to a varying extent. Some teachers seemed to demonstrate everything that was said, while others used this teaching device for the difficult and dangerous experiments only. Still others claimed that no lecture demonstrations were given whatsoever.

Of the students, 56% believed that they were aided in their college

chemistry after they had completed a high-school course; 21% claimed that they were not, while 23% seemed to have been aided to a slight extent. Various expletives accompanied the answers to these questions. Many believed that they were helped during the first semester of college work particularly, while others stated that a knowledge of high-school chemistry actually hindered them in their college course.

Some blamed themselves and claimed that lack of interest and faulty methods of study rendered the high-school course practically useless in their cases. Quite a few, on the other hand, pointed their finger at their high-school instructor and stated that the teacher and the methods of instruction were poor; that the course was taught in cook-book fashion; that it merely touched the surface; that there was an absence of detail, correlation, and organization; that it was taught too methodically or was not sufficiently clear; that explanations of the theory were entirely lacking; that the course was vague, general, and too complicated for high-school students and not sufficiently thorough; that it was presented too rapidly and that class discipline was very poor.

Only 25% of the high-school chemistry group felt that they were influenced in the choice of their life work as a result of having had high-school chemistry. One student, answering this question wrote, "Yes, I decided against chemistry."

As we might naturally expect, most students (66%) enrolled in high-school chemistry in order to acquire knowledge; 26% because it was required; and the remaining 8% elected this course because they felt they would be entertained.

Reactions of the Non-High-School Chemistry Group

Let us consider a few reactions from that group of students who have not taken the high-school chemistry course. Of these, 76% stated that they were laboring under disadvantages, and only 24% felt that they encountered little difficulty in their college course. The comments accompanying this answer pointed out particularly that the subject matter and terminology were entirely new—the fundamentals were difficult to assimilate, the college chemistry course required more time and effort as a result, laboratory work was performed rather slowly and previous knowledge would have made college chemistry a great deal easier. One particular student claimed that he studied the subject privately before coming to college and another felt rather fortunate that he had not taken high-school chemistry, stating that his mind was in a more receptive mood and was kept free from confusing statements.

In answer to the question: "On the basis of your experiences in chemistry this year, would you take the high-school chemistry course if you

were able to repeat your high-school work?" Ninety-two per cent answered yes and only 8% answered no.

Of the non-high-school chemistry group, 45% did not take high-school chemistry because it was not offered; 30% preferred other sciences; 22% were not interested at the time; 3% felt that the course would be too difficult and no one believed that the high-school course was not worthwhile.

Compilation of Data Collected

For the past few years we have made a careful study of the official chemistry grades issued to freshmen from the standpoint of the students' previous training or lack of training in high-school chemistry. These data have been transcribed into the form of graphs, which, I believe, will clearly point out the relationship which exists between the high-school chemistry group and the non-high-school chemistry group. As mentioned before, the student's high-school training in chemistry or the lack of it did not enter into the calculation of his final grade for his college course. His work during the semester in his college course was the deciding factor. Therefore, these data are the result of an impartial investigation, uninfluenced by pre-determined personal convictions in the matter.

Eight hundred twenty-six college chemistry students enrolled in three departments (Liberal Arts, Engineering, and Business Administration) in courses taught by various teachers, though essentially covering similar work during the first semester of 1929 and 1930, form the basis of this presentation.

The relative numbers of students who have had and those who have *not* had previous chemical training in high school vary from year to year. In Group I, numbering 88 students, for example, 48 students had high-school chemistry and 40 had no high-school chemistry—a ratio of 1.2 to 1 in favor of the high-school chemistry group. In Group II, the relationship is 76 to 57, a factor of 1.3 to 1; in Group III, the relationship is 135 to 96, a factor of 1.4 to 1; in Group IV, the relationship is 108 to 53, a factor of 2 to 1; while in Group V, the relationship is 143 to 70, a factor of 2 to 1. These data give an average relationship of 1.6 to 1 in favor of the group that has had high-school chemistry. In order to place each class on an equal numerical basis, as far as previous chemistry is concerned, these factors have been used in the calculation of the percentages which are shown in the tables and the graphs which are to follow.

The letters A to F in the tables and charts represent the grades issued. An A designates a grade of 100 to 93%; B, 92 to 85%; C, 84 to 77%; D, 76 to 70%; E, 69 to 60%; and F, 59to 0%. In a four-credit-hour course, as chemistry, for example, an A merits 12 quality points; B, 8 quality points; C, 4 quality points; while D, though a passing grade,

TABLE NO. I

Grade	Numbers	Percentages	Number who had No High-School Chem.	Number who had High-School Chem.	Number who had No High-School Chem. multiplied by the factor equals	Recalculated number of students who had No High-School Chemistry	Number of students who had High-School Chemistry	Percentages of students who had High-School Chem. on recalculated basis	Percentages of students who had No High-S. Chem. on recalculated basis
GROUP I - BUSINESS ADMINISTRATION - SEM. I - 1928 - 9									
A	12	13.6%	4	8	4 x 1.2 =	4.8	8	62%	38%
B	14	15.9%	3	11	3 x 1.2 =	3.6	11	75%	25%
C	19	21.5%	9	10	9 x 1.2 =	10.8	10	48%	52%
D	22	25.0%	12	10	12 x 1.2 =	14.4	10	41%	59%
E	14	16.0%	7	7	7 x 1.2 =	8.4	7	45%	55%
F	7	8.0%	5	2	5 x 1.2 =	6.0	2	25%	75%
Total	88		40	48	40 x 1.2 =	48	48		
GROUP II - ENGINEERS - SEM. I - 1928 - 9									
A	16	12.0%	4	12	4 x 1.3 =	5.32	12	69%	31%
B	19	14.3%	3	16	3 x 1.3 =	3.99	16	80%	20%
C	29	21.8%	10	19	10 x 1.3 =	13.30	19	59%	41%
D	31	23.3%	14	17	14 x 1.3 =	18.62	17	48%	52%
E	14	10.5%	7	7	7 x 1.3 =	9.31	7	43%	57%
F	24	18.0%	19	5	19 x 1.3 =	25.27	5	16%	84%
Total	133		57	76	57 x 1.3 =	75.81	76		
GROUP III - LIBERAL ARTS - SEM. I - 1928 - 9									
A	17	7.4%	0	17	0 x 1.4 =	0.0	17	100%	0%
B	35	15.1%	15	20	15 x 1.4 =	21.0	20	49%	51%
C	54	23.4%	20	34	20 x 1.4 =	28.0	34	55%	45%
D	54	23.4%	21	33	21 x 1.4 =	29.4	33	53%	47%
E	19	8.2%	11	8	11 x 1.4 =	15.4	8	34%	66%
F	52	22.5%	29	23	29 x 1.4 =	40.6	23	36%	64%
Total	231		96	135	96 x 1.4 =	134.4	135		
GROUP IV - ENGINEERS - SEM. I - 1929 - 30									
A	16	9.9%	1	15	1 x 2 =	2	15	88%	12%
B	15	9.3%	3	12	3 x 2 =	6	12	66%	33%
C	37	23.0%	7	30	7 x 2 =	14	30	68%	32%
D	41	25.4%	9	32	9 x 2 =	18	32	64%	36%
E	22	13.6%	13	9	13 x 2 =	26	9	26%	74%
F	30	18.6%	20	10	20 x 2 =	40	10	20%	80%
Total	161		53	108	53 x 2 =	106	108		
GROUP V - LIBERAL ARTS - SEM. I - 1929 - 30									
A	15	7.0%	2	13	2 x 2 =	4	13	77%	23%
B	30	14.0%	2	28	2 x 2 =	4	28	90%	10%
C	56	26.3%	17	39	17 x 2 =	34	39	53%	47%
D	36	17.0%	10	26	10 x 2 =	20	26	57%	43%
E	24	11.3%	8	16	8 x 2 =	16	16	50%	50%
F	52	24.4%	31	21	31 x 2 =	62	21	25%	75%
Total	213		70	143	70 x 2 =	140	143		

carries with it no quality points. An E grade implies that a condition was incurred and the student must write a second final examination after a certain period of time has elapsed. Should he pass this second examination, he is officially credited with a D; should he fail this examination, the E grade automatically becomes an F or a failure.

In Table No. 1, the reader will find a composite numerical picture of each group. It includes the numbers of students who have received grades ranging from A to F. These numbers have been calculated to percentages for the respective grades in the five groups represented. This summary, likewise, shows the distribution of the students who have had and who have not had high-school chemistry in each class for the

TABLE NO. 2

AVERAGES - SEMESTER I - FIVE GROUPS

YES = Had a Course in High-School Chemistry

NO = Had No Course in High-School Chemistry

	Factor	Number in Class	A		B		C		D		E		F	
			YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
GROUP I	1.2	88	62%	38%	75%	25%	48%	52%	41%	59%	45%	55%	25%	75%
GROUP II	1.3	133	69%	31%	80%	20%	59%	41%	48%	52%	43%	57%	16%	84%
GROUP III	1.4	231	100%	0%	49%	51%	55%	45%	53%	47%	34%	66%	36%	64%
GROUP IV	2	161	88%	12%	66%	33%	68%	32%	64%	36%	26%	74%	20%	80%
GROUP V	2	213	77%	23%	90%	10%	53%	47%	57%	43%	50%	50%	25%	75%
AVERAGES - 5 GROUPS with FACTOR	1.6		79%	21%	72%	28%	57%	43%	53%	47%	40%	60%	24%	76%
T O T A L		826												

various grades. Furthermore, the method of converting the numbers of these two types of students on an equal numerical basis, by the use of the proper factor is also indicated. In the case of each grade the numbers of students who have *not* had high-school chemistry is multiplied by the factor of that particular group. The resulting numbers and the corresponding numbers of students in the class who have actually had preliminary training form the basis of the percentage calculations which are graphically represented in the first five plates which are to follow.

These graphs portray the status of five first-semester groups, three of which were in attendance during 1929 and two during 1930. A sixth graph indicates the *average* of the five groups studied and is a transcription of the summary found in Table No. 2.

These graphs have been prepared on the basis of the first semester results only, since the data for the second semester would present a distorted and incomplete picture, in that a rather large portion of the poorer students are necessarily eliminated at the end of the first semester.

These graphs will tell the story far more clearly than a long, wordy discussion. The solid black lines in the graphs indicate those students who have had high-school chemistry, while the open double lines represent the students who have had no high-school chemistry.

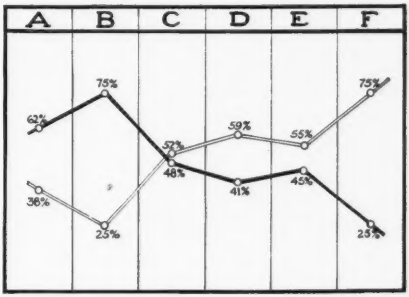

FIGURE 1.—GROUP I—SEMESTER I—1928-29
(*with factor*)

An explanation of the first chart, serving as a model, will suffice to enable the reader to interpret the graphs for the other groups. It must be remembered that the percentages have been recalculated with the proper factor, so that the number of students who have had high-school chemistry is numerically the same (or at least approximately the same) in each group as the number who have not had such previous training.

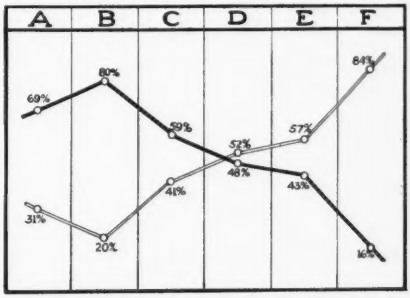

FIGURE 2.—GROUP II—SEMESTER I—1928-29
(*with factor*)

Figure 1 indicates that in this particular group, which was in attendance during the first semester of 1928-29, 62% of the students who were given an A grade had completed a high-school course in chemistry, while 38% had no such previous training. In the B grade, the difference becomes still more pronounced, 75% having had the high-school course, while only 25% had not taken this subject in

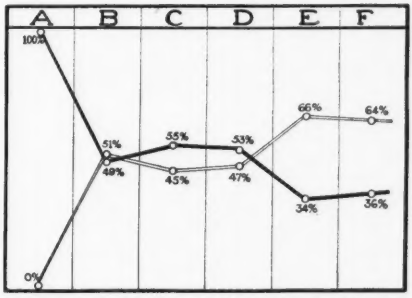

FIGURE 3.—GROUP III—SEMESTER I—1928-29
(*with factor*)

high school. In the C grade the two groups practically converge, the relationship being 48 to 52%. In the D grade, however, the conditions reverse themselves rather sharply, in that over half (59%) of the students who were given a grade of 70 to 76% had *no* high-school chemistry training, while the remainder (41%) had completed such a course. In the E or condition grade the ratio is 55 to 45%. However, in the F or failure group, the curve indicates that 75% of the failures had *no* high-school chemistry, while 25% failed despite the fact that they had completed a course in high-school chemistry.

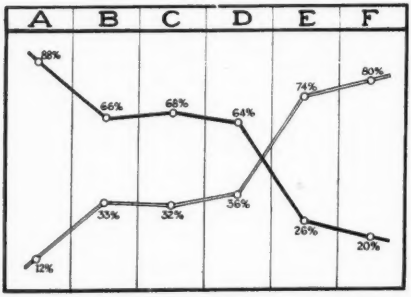

FIGURE 4.—GROUP IV—SEMESTER I—1929-30
(*with factor*)

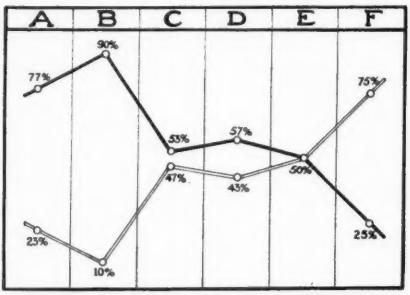

FIGURE 5.—GROUP V—SEMESTER I—1929-30
(*with factor*)

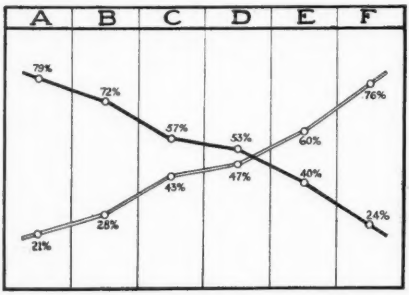

FIGURE 6.—AVERAGE CHART—5 GROUPS
(*with factor*)

Figure 2 tells a similar story, even though an entirely different group is represented. A significant point can be noticed in Figure 3. The reader will observe that all the A students in this group, without exception, strange to say, had taken a high-school course in chemistry. This might explain the reason for the abnormally close relationship, which exists in the percentages for the other grades in this chart. Figures 4 and 5 are also noteworthy, since the lines of demarcation in these cases are very clearly defined. Figure 6 summarizes the status of the five classes studied and indicates a more representative relationship between the high-school and the non-high-school chemistry groups than the individual graphs. This figure graphically represents the average percentages tabulated in Table No. 2.

Summary

The graphs herewith presented seem to bear out our presumptions that the study of high-school chemistry is advantageous to the student who enrols in a college chemistry course, at least in the majority of cases. And yet, we cannot arbitrarily foretell the success of these two classes of students on the basis of previous high-school chemical training alone, since almost invariably a certain number of university freshmen receive an A grade, in spite of the fact that the subject was new to them, not having had a high-school chemistry course, just as we shall always find a certain number of college chemistry students represented in the lower register of the scale, even though they were favored with the advantages of a course in high-school chemistry.

Students who elected chemistry in high school may be, in general, more intelligent or more intellectually industrious, or may exhibit greater aptitude for chemistry than those who did not take this course. As a general rule the non-high-school chemistry group must exert itself more energetically in order to merit a high grade in college chemistry. On the other hand, we also find that students who have had a high-school chemistry course are very likely to be imbued with a kind of superiority complex. At least some of them, it seems, erroneously consider the college course to be merely a repetition of the matter presented in high school. This type of student depends entirely upon acquired knowledge and drifts along nonchalantly until the mid-semester period, when he is suddenly jolted into the realization that he has been idling away his time and that the theoretical discussions have reached a point where they have transcended his intelligence. In other words, there will always be some college students who will do excellent work in spite of the fact that they had no previous high-school chemistry training, just as our classes will always contain students who will do mediocre work, even though their college entrance credit card included a high-school course in chemistry. Be that as it may, these isolated cases are the exceptions rather than the rule.

The reader, however, must remember that any conclusions drawn from the study of so small a group over so short a period of time must be tempered by the consideration of the fact that the students who had chemistry in high school were not compared with those who had not, by means of intelligence or aptitude tests. Nevertheless, the graphs presented in this discussion seem to indicate that the acquisition of high-school chemistry is advantageous to the college chemistry student and is very likely to have a bearing upon the grade obtained in the college course.

Be not elated by fortune, be not depressed by adversity.—CLEOBULUS

A SYSTEMATIC ANALYSIS OF THE ANIONS. II

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PART IV

Procedure III. Analysis of Group III

1. Precipitation of the Cadmium Salts.—To the filtrate from Group II, Procedure II, 1, add a slight excess of a 2*N* cadmium acetate solution. Filter the mixture by gentle suction, using filter paper pulp to prevent the finely divided precipitate from passing through the filter paper. Wash the precipitate with hot water.

2. Identification of the Ferricyanide Ion.—Transfer the precipitate to a small beaker and treat it with from 10 to 20 ml. of 3*N* NH_4OH. Stir the mixture thoroughly, filter quickly, and wash the residue. The filtrate contains most of the ferricyanide and may contain a little ferrocyanide. Acidify the solution with HCl and add a few drops of $FeCl_3$. If a dark blue precipitate is formed (showing the presence of a ferrocyanide) filter the mixture, repeatedly if necessary, and to the clear filtrate add a *freshly prepared* solution of ferrous ammonium sulfate. A dark blue precipitate shows the presence of a *ferricyanide*.

3. Identification of the Sulfide Ion.—Transfer to a small beaker the residue insoluble in 3*N* NH_4OH. Add 5 to 10 ml. of 3*N* HCl, cover the beaker with a watch glass having on its under side a strip of a filter paper moistened with lead acetate solution. Warm the mixture. A brown or black coloration of the lead acetate paper, caused by the formation of PbS, indicates the presence of a *sulfide*.

4. Identification of the Ferrocyanide Ion.—If a test for ferrocyanide has not been obtained in Procedure II, 2, or in the test for ferricyanide in Procedure III, 2, cool the solution which has just been tested for a sulfide and add to it $FeCl_3$ solution. A dark blue precipitate shows the presence of a *ferrocyanide*.

TABLE IV

Procedure III. Analysis of Group III

Filtrate from Group II. Add $Cd(CH_3CO_2)_2$		
Precipitate: CdS, $Cd_2Fe(CN)_6$, $Cd_3(Fe(CN)_6)_2$, $[Cd(CN)_2]$, $[Cd(BO_2)_2]$. Treat with 3*N* NH_4OH		
Residue: CdS, $Cd_2Fe(CN)_6$. Add HCl, warm, hold $Pb(CH_3CO_2)_2$ paper in vapors		*Filtrate:* $Fe(CN)_6^{=}$, $[Fe(CN)_6^{\equiv}]$, (CN^-), (BO_2^-). Add HCl, $FeCl_3$, filter. Add $Fe(NH_4)_2(SO_4)_2$. Dark blue color shows *Ferricyanide*
$Pb(CH_3CO_2)_2$ paper: Brown or black color, PbS, shows *Sulfide*	*Solution:* Add $FeCl_3$. Dark blue color shows *Ferrocyanide*	

Discussion of the Analysis of Group III

The precipitation of the sulfide, ferrocyanide, and ferricyanide ions by cadmium acetate in a neutral solution is almost complete. Cadmium cyanide may also be precipitated if a high concentration of the cyanide

* From a thesis submitted by Miss Alice D. Duschak to the Graduate School of the University of Minnesota in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

ion is present, but it will be almost completely dissolved in the $3N$ NH_4OH, and will not interfere with the analysis of the group. A sufficient amount always remains in solution to give a precipitate with the nickel nitrate used to precipitate the ion in the next group.

The Ferricyanide Ion.—Cadmium ferricyanide dissolves fairly easily in $3N$ NH_4OH, while cadmium ferrocyanide is very slightly soluble in NH_4OH of this concentration. The separation is not complete, a little ferrocyanide being dissolved with the ferricyanide. However, the small amount of ferrocyanide in the solution is easily removed by treating the acidified solution with ferric chloride. If a dark blue precipitate is formed, indicating the presence of ferrocyanide, it is removed by filtration. The solution should be filtered quickly since free NH_3 slowly reduces the ferricyanide. The clear filtrate is tested for ferricyanide with ferrous ammonium sulfate, which forms with the ferricyanide ion a dark blue precipitate of Turnbull's blue, $Fe_3[Fe(CN)_6]_2$.

The Ferrocyanide Ion.—If only a trace of ferrocyanide is present, it may be all dissolved in the NH_4OH and found with the ferricyanide. If a larger amount is present, the greater part of it will remain undissolved and will be found in the hydrochloric acid solution after the removal of the sulfide. The test for the ferrocyanide ion depends on the formation of the dark blue precipitate, Prussian blue, $Fe_4[Fe(CN)_6]_3$, on the addition of ferric chloride to the acidified solution.

The Sulfide Ion.—Cadmium sulfide, unlike most cadmium salts, is almost insoluble in NH_4OH and is left undissolved after the treatment with $3N$ NH_4OH. It dissolves, however, on warming with $3N$ HCl, with the evolution of hydrogen sulfide. The H_2S, coming in contact with a filter paper moistened with lead acetate, forms lead sulfide which is brown or black.

PART V

Procedure IV. Analysis of Group IV

1. Precipitation of Nickel Cyanide and Identification of the Cyanide Ion.—To the filtrate from Group III add $2N$ $Ni(NO_3)_2$ solution until no more precipitate is formed, then 1 or 2 ml. more. Allow the mixture to stand at least ten minutes, frequently stirring or shaking it, then filter, using filter paper pulp. Wash the precipitate thoroughly, rejecting the washings so as not to dilute the filtrate excessively. Dissolve the precipitate in NH_4OH, and add an excess of ammonium polysulfide (yellow ammonium sulfide). Heat the mixture to boiling and filter off the NiS. The filtrate may be colored brown by colloidal NiS. In either case evaporate the solution *just* to dryness and dissolve the residue in $3N$ HCl. Filter out any precipitate and to the clear solution add a little $FeCl_3$ solution. A deep red color, $Fe(CNS)_3$, shows the presence of a cyanide.

2. Identification of the Thiocyanate Ion.—Acidify a small portion of the filtrate from the $Ni(CN)_2$ precipitate with HCl, and add a little $FeCl_3$. A deep red color indicates the presence of a thiocyanate. If the color is brown rather than red it may be due to iodine. In this case transfer the solution to a separatory funnel, add 5 ml. of CCl_4, and shake the mixture. If a pink or purple color in the CCl_4 shows I_2 to be present,

extract the solution with successive fresh portions of CCl_4, adding more $FeCl_3$ if the water layer becomes decolorized. If the water layer is still colored red the presence of a thiocyanate is confirmed.

3. Precipitation and Solution of the Silver Salts. Identification of the Thiosulfate Ion.—To the remainder of the filtrate from Procedure IV, 1, add an excess of $AgNO_3$ solution. A light precipitate turning yellow, then brown or black indicates the presence of a thiosulfate. This color change, caused by the decomposition of $Ag_2S_2O_3$, is a sufficient test for the thiosulfate ion. If a large amount of light-colored precipitate makes the test inconclusive, a special test must be made on a separate portion of the original solution, and may be carried out as follows: if a sulfide is present, add an excess of $Cd(CH_3CO_2)_2$; if a sulfite is present, add $Ba(CH_3CO_2)_2$, and filter the mixture. To oxidize and remove any traces of these ions remaining, acidify the filtrate with HCl and add a few ml. of $BaCl_2$ and a little I_2 solution. If a precipitate forms, filter it off, and add to the clear filtrate a saturated solution of Br_2. A white precipitate of $BaSO_4$ is now an indication of the presence of a thiosulfate.

To the mixture containing the silver precipitate add a slight excess of HNO_3 and heat it to boiling. Filter the mixture while hot, and wash the precipitate well with hot water, finally drying it by suction as completely as possible. Reserve the filtrate.

If a thiocyanate has been found present, separate the precipitate from the filter paper as completely as possible, and transfer it to a porcelain crucible. Burn the paper separately in a spiral of platinum wire or on a crucible cover, and add the ash to the precipitate in the crucible. Dry the precipitate and ignite it at a dull red heat to destroy the AgCNS. Allow the crucible to cool, pulverize the residue, and mix it in the crucible with 5 to 10 grams of a mixture of equal parts of Na_2CO_3 and K_2CO_3. Heat the crucible over a Tirrill burner until the mixture is fused. Dissolve the melt so far as possible in hot water and acidify the mixture with HNO_3. Heat it to boiling and filter off the insoluble residue, which contains the silver halides. Reject the filtrate. Transfer this residue (or the original silver precipitate in the absence of a thiocyanate) to a small beaker, and add 5 to 10 ml. of concentrated NH_4OH. If the material was the original silver precipitate, a white insoluble residue is probably AgI. Add ammonium monosulfide (colorless ammonium sulfide, which should be freshly prepared), a few drops at a time until no further precipitate is produced. Digest the mixture at the boiling temperature for a few minutes, allow it to settle, and add a few more drops of $(NH_4)_2S$. If more precipitate is formed, repeat the process until all the silver is precipitated as the sulfide. Filter out and reject the precipitate. Boil the filtrate to a small volume to decompose all the $(NH_4)_2S$, and filter off the sulfur if necessary.

4. Identification of the Iodide Ion.—Pour the cooled solution into a separatory funnel, add 1 ml. of HNO_3 and 2 ml. of CCl_4, then $Fe(NO_3)_3$ solution until the solution is distinctly yellow. Shake the mixture well. A violet color in the CCl_4 indicates the presence of an iodide.

5. Identification of the Bromide Ion.—If an iodide has been found to be present, transfer the solution to a beaker, and boil it until the iodine is expelled, adding more ferric nitrate if necessary. Usually boiling for one minute is sufficient. Cool the solution, return it to the separatory funnel, add 2 ml. of CCl_4, and shake the mixture. If iodine is now absent, add 2 ml. more of HNO_3 then $KMnO_4$ solution drop by drop until the water layer is purple. Shake the mixture. A yellow or orange coloration of the CCl_4 due to free bromine indicates the presence of a *bromide*.

6. Identification of the Chloride Ion.—Reject the CCl_4 layer and transfer the H_2O layer to a beaker. If a bromide has been found to be present dilute the solution to about 40 ml. and boil it for 5 minutes adding more $KMnO_4$ if the purple color disappears. Pass SO_2 into the solution to reduce the permanganate, and boil off the

excess SO_2. Filter the solution if it is not clear, and add $AgNO_3$. A white precipitate, AgCl, indicates the presence of a *chloride*.

TABLE V

Procedure IV. Analysis of Group IV

Filtrate from Group III. Add $Ni(NO_3)_2$.

Precipitate: $Ni(CN)_2$ Add NH_4OH $(NH_4)_2S_x$		*Filtrate:* Cl^-, Br^-, I^-, CNS^-, $S_2O_3^=$, etc. Divide into two portions						
Precipitate: NiS. Reject	*Filtrate:* Add HCl, $FeCl_3$ Red color $Fe(CNS)_3$ shows *Cyanide*	*Small Portion:* Add HCl, $FeCl_3$. Red color $Fe(CNS)_3$ shows *Thiocyanate*	*Large Portion:* Add $AgNO_3$, HNO_3					*Filtrate:* Reserve
			Light precipitate turning dark shows *Thiosulfate*. Yellow precipitate shows *Bromide* or *Iodide*. White precipitate shows *Chloride* or *Thiocyanate*. Ignite, fuse with Na_2CO_3 and K_2CO_3. Treat melt with H_2O, HNO_3					
			Residue: Add NH_4OH, $(NH_4)_2S$				*Filtrate:* Reject	
			Residue: Ag_2S. Reject	*Filtrate:* Cl^-, Br^-, I^-, Add HNO_3, $Fe(NO_3)_3$, CCl_4				
				CCl_4 layer: Violet color shows *Iodide*	*Water layer:* Boil, Add HNO_3, $KMnO_4$, CCl_4			
					CCl_4 layer: Yellow or orange color shows *Bromide*	*Water layer:* Boil, Add SO_2, $AgNO_3$. White precipitate shows *Chloride*		

Discussion of the Analysis of Group IV

The Cyanide Ion.—Nickel nitrate is used to precipitate the cyanide ion in order to effect a separation from the thiocyanate ion, which is otherwise difficult. The use of a separate reagent for one ion seems justified in this case, though usually not to be recommended. Nickel cyanide precipitates slowly, and because of its solubility in excess alkali cyanide with formation of a complex ion, the precipitation is not complete unless an excess of the nickel ion is present. It is likewise important that the nickel cyanide precipitate be well washed, for any thiocyanate occluded in the nickel precipitate would give a red color with ferric chloride and this be mistaken for a cyanide. The confirmatory test for the cyanide ion depends on the formation of the thiocyanate ion by the combination

of the cyanide ion with the excess sulfur of the polysulfide after the $Ni(CN)_2$ has been dissolved in NH_4OH. The nickel forms the complex nickel-ammonio ion and is precipitated from this solution as nickel sulfide.

The Thiocyanate Ion.—The thiocyanate ion is very easily detected in a small portion of the filtrate by the formation of the characteristic deep red of ferric thiocyanate on the addition of ferric chloride. The brown color of iodine should not be mistaken for this red color, but may mask it if a high concentration of the iodide ion is present. After repeated extraction of the solution with CCl_4, however, not enough iodine will remain to interfere with the test. The test for a thiocyanate is made at this point because if present it must be destroyed before the tests are made for the halides. If not destroyed, the thiocyanate ion interferes with the test for the bromide ion, which cannot be detected in the presence of much thiocyanate.

The Thiosulfate Ion.—Silver thiosulfate, when precipitated from a neutral solution, almost immediately decomposes, going through several color changes and finally forming silver sulfide and sulfate. This is a sensitive and specific test for the ion unless such a large white or yellow precipitate is formed as to obscure the color change. In this case a special test is made, which depends on the oxidation of the thiosulfate to the sulfate ion and precipitation as barium sulfate.

The Halides.—The halides and the thiocyanate are completely precipitated by silver nitrate. The mixture is acidified with nitric acid and boiled to dissolve any $AgBrO_3$ which might have precipitated from the neutral solution, and to increase the solubility of $AgCH_3CO_2$ which is likely to precipitate if a large amount of the acetate ion has been added in the precipitation of the preceding groups. To keep these two salts in solution the mixture is filtered while hot and thoroughly washed with hot water.

AgCNS is completely destroyed by ignition at dull red heat, while the silver halides remain unchanged. By fusion with the alkali carbonates the ignited halides are changed into a form in which they are easily acted upon by NH_4OH and $(NH_4)_2S$ after solution of the melt in dilute nitric acid. The silver is thus precipitated as the sulfide while the halides are changed into soluble ammonium salts.

The iodide ion is the only one of the halides oxidized to the free halogen by the ferric ion, even on boiling in the presence of a slight excess of nitric acid. The characteristic purple color of the solution of the free halogen in CCl_4 constitutes a sensitive and specific test for an iodide. On boiling the acid solution containing an excess of ferric nitrate, the iodine is entirely oxidized and expelled.

On treating the nitric acid solution with $KMnO_4$ the bromide ion is

oxidized to free bromine, which on extraction with CCl_4 gives a characteristic yellow or orange color, depending on the concentration. On boiling the solution containing an excess of permanganate the bromine is all oxidized and expelled, while the chloride ion is not appreciably oxidized in the solution of low hydrogen-ion concentration.

Since the thiocyanate, iodide, and bromide ions have all been destroyed, the formation of a white precipitate with silver nitrate after the reduction of the permanganate is a specific test for a chloride. Since chlorides are common impurities in chemical reagents, a small precipitate cannot be taken as proof of the presence of a chloride in the original unknown, unless a blank test is made on all of the reagents used.

PART VI

Procedure V. Analysis of Group V

1. Identification of the Hypochlorite Ion.—Test a small portion of the original unknown solution for a hypochlorite as follows: Make the solution acid with CH_3CO_2H, add 5 ml. of lead acetate solution, heat the solution to boiling, and allow it to stand for five minutes. The appearance of a dark brown precipitate of PbO_2 is a specific test for a hypochlorite. If anions are present whose lead salts are insoluble, they should be removed by the appropriate group reagents before testing for the hypochlorite ion, since otherwise the precipitate formed may hide the PbO_2 precipitate and thus invalidate the test.

2. Identification of the Chlorate, Bromate, and Iodate Ions.—Acidify another portion of the unknown solution with HNO_3, and, if a hypochlorite has been found to be present, add 5–10 ml. of sodium arsenite solution to reduce the hypochlorite to a chloride. Add $AgNO_3$ solution until all the insoluble silver salts are precipitated. Without heating the mixture, filter it at once and reject the precipitate. Add a little more $AgNO_3$ to make sure that the precipitation has been complete. Then pass SO_2 into the solution or add H_2SO_3 until it smells strongly of SO_2. The SO_2 reduces the chlorate, bromate, and iodate ions to their respective halides. Boil the mixture until the smell of SO_2 is gone. If a precipitate remains, add more $AgNO_3$ until the precipitation is complete. Filter the mixture and wash the precipitated silver halide. Reserve the filtrate to be analyzed for the perchlorate ion, and analyze the precipitate as directed for the silver precipitate in Group IV, Procedure IV, omitting the test for the thiocyanate. A test for a chloride here indicates a *chlorate*, a bromide indicates a bromate, and an iodide an iodate. The tests for an iodate and a bromate should not be omitted if these ions were not found in Group II, Procedure II, for a small amount of an iodate and a somewhat larger amount of a bromate may be missed completely in the analysis of that group, owing to the fact that the barium salts are somewhat soluble even in the presence of acetone. If tests for these ions were obtained in Group II tests need not be made for them again, but after the reduction with SO_2 the bromide and iodide must be oxidized and removed before reprecipitating AgCl in the test for a chlorate. In the presence of a bromide or iodide the tests for the bromate and iodate ions should be made on the filtrate from Group IV, 3, rather than on a fresh portion of the solution. The test for a chlorate must, however, always be made on a fresh portion of the original solution as directed.

3. Identification of the Perchlorate Ion.—Add to the filtrate from Procedure V, 2, a little more $AgNO_3$ to insure the complete removal of the halides, filter if a precipitate

forms and evaporate the solution to a small volume. Transfer it to a porcelain crucible and evaporate it carefully to dryness. To the dry residue add a mixture of equal parts of sodium and potassium carbonates (chloride free), and heat the mixture with a hot Bunsen flame until it is fused. Cool the melt, and extract it with hot water. Make the solution acid with HNO_3, and boil it for a minute to expel CO_2. If the melt does not completely dissolve, filter the mixture and add $AgNO_3$ to the filtrate. A white precipitate of AgCl shows the presence of a perchlorate. If no precipitate is formed, treat the residue with dilute NH_4OH. Filter the mixture, and acidify the filtrate with HNO_3. A white precipitate of AgCl indicates a *perchlorate.*

4. Identification of the Nitrate and Nitrite Ions.—In the absence of a nitrite the nitrate ion may be identified in a portion of the original unknown by ferrous sulfate and concentrated sulfuric acid giving the familiar brown ring test, or by heating the solution (from which ammonium salts have been removed by heating with NaOH) with NaOH and metallic aluminum and testing the vapors for NH_3 with moist red litmus paper. Other ions besides the nitrite which interfere with the brown ring test are the bromide, iodide, bromate, iodate, thiocyanate, ferrocyanide, and ferricyanide ions. The halides, oxyhalogen salts, and thiocyanate can be removed by precipitation with silver sulfate or silver acetate. The excess silver ion can be precipitated with sodium chloride. The ferro- and ferri-cyanide ions can be precipitated by cadmium acetate. The test for the nitrate is then carried out in the filtrate from which the precipitate has been removed.

If the nitrite ion is present it will also give these tests, and it must therefore be tested for and removed before analyzing the solution for a nitrate. Test a portion of the original unknown for a nitrite by a hydrochloric acid solution of urea. Immediate evolution of gas bubbles indicates the presence of a nitrite. If a carbonate is present it must be removed before carrying out the test, otherwise an evolution of CO_2 alone might be mistaken for the test for a nitrite. This is done by acidifying the solution with HCl before adding the urea solution. The nitrite ion may also be detected by the formation of a brown color on acidifying the solution with acetic acid and adding a solution of $FeSO_4$.

To remove a nitrite from the solution which it is desired to test for a nitrate, add 2 or 3 grams of solid ammonium sulfate to the neutral solution and boil it until the nitrite is decomposed. Replace the water lost by evaporation. This process may take one-half hour or more. A small amount of the solution is removed at intervals and tested for the nitrite ion until it is found to be absent. The solution is then cooled and tested for a nitrate with a solution of $FeSO_4$ and concentrated H_2SO_4.

5. Identification of the Metaborate or Tetraborate Ion.—Make a portion of the unknown solution slightly alkaline with NaOH and evaporate it almost to dryness. Test this material for a borate by the method of Gabriel and Tanner (*9*), inserting an air trap between the mouth and the test tube containing the material which is being tested.

Discussion of the Analysis of Group V

The Hypochlorite Ion.—In the hot solution, neutral or slightly acid with acetic acid, lead acetate is oxidized to PbO_2 by the hypochlorite ion. The test is specific and very sensitive.

The Chlorate, Bromate, and Iodate Ions.—The hypochlorite ion, if present, is easily reduced by sodium arsenite in the cold solution slightly acid with HNO_3, while the other oxyhalogen ions are not affected. The chloride thus formed is removed by precipitation with $AgNO_3$ together with any ions already present which form insoluble silver salts. The

hypochlorite must be reduced before the $AgNO_3$ is added, for silver hypochlorite decomposes spontaneously into the chloride and the chlorate, and thus a test for a chlorate might be obtained where only a hypochlorite was originally present.

The chlorate, bromate, and iodate ions are easily reduced by SO_2 to their respective halides. The solutions must be boiled to drive off the SO_2, for otherwise the precipitate of silver sulfite first formed may be mistaken for silver chloride. The separation and identification of the halides is carried out as in Group IV.

The Perchlorate Ion.—The perchlorate ion is not reduced by SO_2, and is therefore left in the filtrate from the reduction and precipitation of the other oxyhalogen ions. On fusing the residue (left from the evaporation of the filtrate) with Na_2CO_3 and K_2CO_3, the perchlorate is decomposed into a chloride and free oxygen. After dissolving the melt in water and destroying the carbonate by acidifying the solution with HNO_3 and boiling off the CO_2, the chloride is precipitated with $AgNO_3$. A residue insoluble in dilute HNO_3, left after dissolving the salt, may contain AgCl. If the solution fails to give the test for a chloride, this residue is tested for the presence of AgCl by treating it with NH_4OH and then acidifying the resulting solution with HNO_3. If AgCl is present it is dissolved in the NH_4OH and reprecipitated by the HNO_3.

Small precipitates of AgCl may be found in the tests for the chlorate and perchlorate ions, due to impurities in the reagents. A blank test for chlorides should therefore be made on the reagents used for both of these tests.

The Nitrate and Nitrite Ions.—A solution of a nitrate on being treated with ferrous sulfate and concentrated H_2SO_4 is reduced to NO which combines with the excess of ferrous sulfate to give the brown compound $FeSO_4 \cdot NO$. The nitrite ion gives the same test much more easily because nitrous acid is much more unstable than nitric acid, and is set free and reduced in the presence of weak acids such as acetic acid. Both ions are reduced to NH_3 by warming with metallic aluminum and NaOH, and NH_3 evolved turns the moist red litmus paper blue. Urea decomposes nitrous acid very readily with a vigorous evolution of carbon dioxide and nitrogen.

The Metaborate and Tetraborate Ions.—When a borate is heated with sulfuric acid and methyl alcohol the volatile methyl ester of boric acid, $B(OCH_3)_3$, is formed which burns with a green flame. Copper and barium salts, which give a green color to a flame, do not interfere with this test, since only the volatile components of the solution are carried into the flame. The air trap is used to prevent the hot acid solution from backing up into the mouth in case the capillary should become stopped up in any way.

Conclusions

A series of quantitative experiments was performed to test the completeness of the separation of the anions and the sensitivity of the tests for individual ions according to the system of analysis here outlined. The results are tabulated in Table VI.

TABLE VI

Group	*Ion*	*Minimum Amount Precipitated in Group*	*Amounts of Other Ions Present*	*Amount Detected in Confirmatory Test*
	Numerical values refer to mg. per 10 ml. of solution			
I	$CO_3^=$	1		1
	$SO_3^=$	8		8
	$PO_4^{\equiv}$	0.4		0.5
	$PO_4^{\equiv}$	0.4	F^-, 500	0.5
	F^-	1		2
	F^-	(Precipitate tested directly for F^-)		1
	IO_3^-	125		
	$Fe(CN)_6^{\equiv}$	175		
II	$SO_3^=$	2		3
	$SO_4^=$	0.25		0.5
	BrO_3^-	45		45
	BrO_3^-		IO_3^-, 100	45
	IO_3^-	4		5
	IO_3^-		$CrO_4^=$, 500	5
	$CrO_4^=$	0.5		0.5
	$Fe(CN)_6^{\equiv}$	30		
	$S_2O_3^=$	45		
III	$Fe(CN)_6^{\equiv}$	0.5		0.5
	$Fe(CN)_6^{\equiv}$		CN^-, 500	1
	$Fe(CN)_6^{\equiv}$	0.5		0.5
	$Fe(CN)_6^{\equiv}$		$Fe(CN)_6^{\equiv}$, 500	1
	$Fe(CN)_6^{\equiv}$		CN^-, 500	2
	$S^=$	0.25		0.25
	$S^=$		$Fe(CN)_6^{\equiv}$, 500	1
	CN^-	50		
IV	CN^-	2		2
	CNS^-	0.5		0.5
	$S_2O_3^=$	0.5		0.5
	$S_2O_3^=$		Cl, 500	1 (doubtful)
	I^-	0.5		1
	I^-		CNS^-, 500	2
	Br^-	0.5		1
	Br^-		I^-, 500	2
	Br^-		CNS^-, 500	2
	Cl^-	0.5		0.5
	Cl^-		I^-, 500; Br^-, 500	1
	IO_3^-	3		
	BrO_3^-	50		

TABLE VI—(*Continued*)

V	IO_3^-	1		2
	BrO_3^-	1		2
	ClO_3^-	1		1
	ClO_4^-	1		1
	ClO_4^-		ClO_3^-, 500	1
	NO_2^-	($FeSO_4$ + CH_3CO_2H test)		2
	NO_2^-	(Urea + HCl test)		1
	NO_3^-	($FeSO_4$ + H_2SO_4 test)		2
	NO_3^-	(NaOH + Al test)		1
	NO_3^-		NO_2^-, 500	3
	BO_2^-	(Reaction in flask)		5
	BO_2^-	(Reaction in test tube with capillary)		0.5
Special tests	$SO_3^=$	(Test with $BaCl_2$ and I_2)		1
	$S_2O_3^=$	(Test with $BaCl_2$ and Br_2)		1

Because of the difference in actual unknowns analyzed, it was somewhat difficult to make accurate comparison of the analytical results obtained by the use of this scheme with those obtained by other methods. It may be said that without question the results were distinctly better than those obtained by the use of other systems by our classes. The results obtained by a class of 22 students are tabulated in Table VII.

TABLE VII

Total number of unknowns analyzed	196
Number of perfect reports	92
Per cent of perfect reports	47%
Number of reports 75% perfect or over	138
Per cent of reports 75% perfect or over	70.5%
Per cent correct reports on individual ions	74%

Literature Cited

(9) GABRIEL and TANNER, *J. Am. Chem. Soc.*, **50**, 1385 (1928).

Public Gets Benefit of Poison Gas Patent. An international race for a patent on a poisonous gas has been won by the U. S. Department of Agriculture, and the public will get the benefit.

Two scientists of the Department, Dr. Ruric C. Roark and Dr. Richard T. Cotton, discovered that ethylene oxide is an exceedingly effective destroyer of weevils and other insects that infest stored food products. A well-known German dye company patented the gas for use as a fumigant abroad, and applied for a patent in this country. However, the priority of the American scientists' claim was recognized by the U. S. Patent Office, and their patent has been dedicated to public use.

The same substance has another usefulness which was discovered by Prof. R. B. Harvey of the University of Minnesota. In its liquid form, it can be injected into the soil among the roots of weeds, poison ivy, barberry bushes, or other undesirable plants, killing them within a few hours.—*Science Service*

Correspondence

STANDARDIZED NOTATION FOR TITRE

DEAR EDITOR:

The titre method of making computations in quantitative analysis is gradually coming into general use and for that reason there should be adopted an abbreviation for the word, just as the letter *N* is commonly understood to mean normality. In my reading I have found no similar expression for titre and have therefore found it necessary to create one for use in my classes.

The symbol, Na_2CO_3 *T* HCl, is understood in our classes to mean the sodium carbonate titre of an HCl solution, and of course all other titres can be expressed in a like manner.

If possible I should like to publish this letter for two reasons:

(1) To ask if a system of abbreviation has been adopted in any considerable number of schools.

(2) To suggest that, if no other system is generally employed, this system be adopted.

W. P. CORTELYOU

THE NEW YORK STATE SCHOOL OF CLAY-WORKING & CERAMICS
AT ALFRED UNIVERSITY
ALFRED, N. Y.

MOTION PICTURES AVAILABLE FOR FREE USE IN EDUCATIONAL INSTITUTIONS

DEAR EDITOR:

Will you please eliminate, for the time being, our film "The Chemical Ethyl Alcohol" from the list of free films in your publication? (See p. 730 of the April issue.) When this film becomes available again we will advise you.

You may substitute for the above a film we have, entitled "Cotton—The Making of a Turkish Towel." This is a one-reel film which tells the complete story from the picking of cotton to the finished product, and is available in either 16 mm. or 35 mm. width.

DE FRENES & CO.

WILKES-BARRE, PENNA.

THE ICONOCLAST—CORRECTIONS

DEAR EDITOR:

In the last issue of the JOURNAL I enjoyed the article entitled "The Iconoclast," by FREDERIC WALKER; but I wish to bring to your attention a slight but unfortunate error made by the author in the translation of the motto of Paracelsus,

"Alterius non sit, qui suus esse potest,"

which was rendered,

"He who is not able to be his own will be another's."

This misses the point of experimental science, the motto of which, as expressed by Paracelsus, is

"Whoever can be his own, let him not be another's."

JOHN E. RICCI

NEW YORK UNIVERSITY
UNIVERSITY HEIGHTS, N. Y.

DEAR EDITOR:

Like Paracelsus I find myself questioned on the subject of my Latin. Mr. Ricci is quite right and his translation is better and more accurate than my own version of the motto.

There is also another correction to which I should like to call the attention of the readers of my paper. Twice in the article (pp. 890 and 893) a statement appears to the effect that Galen was probably driven in exile from Pergamum by the doctors of his time. The statement should be corrected to read that he was driven from Rome. This correction was made before the publication of the article but it was received too late to have it included in the May JOURNAL.

FREDERIC WALKER

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A COURSE IN ELEMENTARY BLOWPIPE ANALYSIS AS A FUNDAMENTAL LABORATORY PROJECT IN HIGH-SCHOOL CHEMISTRY

The chemistry course used in Orange Union High School, Orange, California, features an elementary course in blowpipe analysis. This supplementary course, which is somewhat of an innovation in high-school chemistry, was introduced as an experiment by our chemistry instructor, Mr. Vernon C. Shippee. The students have enjoyed their work with "unknowns" to such an extent that this feature of the course has been retained permanently.

The reaction of the students toward this work in blowpipe analysis is, as a rule, enthusiastic. This type of work is very fascinating and a large percentage of the students become greatly interested in the course and follow it through with great zest. In fact, the interest displayed in this work is so great that a "deadline" for finishing the work in blowpipe analysis is almost unnecessary.

In order that the students may not work in the dark they are issued a copy of "Notes on Blowpipe Analysis," by Dr. Nicholas Knight. After they have read this pamphlet through, the instructor gives a lecture demonstration on the use of the book. This demonstration consists of the analysis of some typical compounds, calling on the students to follow the course of the analysis by checking the key references in the pamphlet.

It is presumed that by now the students have enough general knowledge to do the work by themselves. They are, therefore, issued five "knowns," or substances, the composition of which is known to the class. The composition of these substances must be verified and the written tests, or proofs, of the analysis must be submitted to the instructor. At this point the instructor demands accurate, clean-cut work. If the students learn how to use the "little red book" intelligently and systematically when working their "knowns," then their work will be much easier when they tackle their "unknowns." The five knowns are, of course, selected to amplify the range of tests shown in the lecture demonstration.

The students are now ready to try their first unknowns. Two are issued by the instructor to each member of the class. These two unknowns must be correctly analyzed before any more are issued. The correct write-up of the analyses must be handed in. The issuing of the unknowns two at a time allows the student a little more judicious use of his time, and cuts down on the amount of detail work required of the instructor. On these first unknowns the instructor frequently helps the students and corrects errors that arise from faulty technic due to lack of practice in the work. He also impresses upon the students the folly of slipshod work and the value of careful observation of gaseous products, peculiar odors, significant colors, or any other peculiarities exhibited by the substance being analyzed.

In issuing samples the instructor uses the utmost secrecy. The unknowns are kept in one-ounce bottles which are emptied rapidly and are changed from time to time. The instructor keeps the key list to the unknowns and no one but he or his assistant has access to it.

Each student is required to keep a small notebook in which are recorded the following data concerning the unknowns: chemical name; common name, if any; formula; analysis. Under "analysis" the student is required to write up any difficulties encountered and also the peculiarities exhibited by the various compounds. Slipshod or incorrect write-ups are

returned and must be rewritten correctly before any grade is given. A sample write-up follows.

I. Cobalt Sulfate $CoSO_4$ No common name.

A. A small portion of the substance heated on a clean charcoal block yielded a dark blue to black residue. A speck of the original substance is now fused with a clear borax bead, and imparts to the bead a blue color, showing the presence of cobalt.

B. A small portion of the substance is put in a clean, dry test tube and is treated with concentrated sulfuric acid. The substance remains inactive, even when heated, although the color changes from reddish to blue, due to the dehydrating action of concentrated sulfuric acid.

C. A water solution of the substance when treated with barium chloride solution yielded a white precipitate, insoluble in hydrochloric acid, confirming the presence of a sulfate.

As a student who has just finished this course in unknowns the writer feels safe in stating that the course is of inestimable value. First-hand knowledge is gained as to the basic laws of analytical chemistry. Chemical equilibrium, and its displacement by heat, knowledge of solubilities, and observation of gaseous products are some of the factors gained from the course. The course also makes an ideal basic foundation for more advanced work in analysis. If the student does not go on to college the course is still of great value. The average person in daily life frequently needs to know or would profit greatly if he did know the composition and reaction of various chemical compounds. This course fits a person so that he is able, if need be, to analyze any simple compound he runs up against. The writer feels that an elementary course in blowpipe analysis should be included in all high-school chemistry courses.

EARL MCANDRESS

ORANGE UNION HIGH SCHOOL
ORANGE, CALIFORNIA

What Is a Chemist? *The answer seems to depend somewhat upon which side of the ocean he is on.* In Great Britain, where the pharmacist has long been called "chemist" and the pharmacy known as a "chemist's shop," there is a movement to get away from the old designations and to adopt the American nomenclature. On the other hand, some American pharmacists call themselves chemists. This latter practice is not approved by the Journal of *Industrial and Engineering Chemistry*, published by the American Chemical Society, but quite the contrary. Says the *Journal*, with some show of choler:

> Success is always capitalized, sometimes by those who have contributed to it, but often by those who, though having no part in it, would subvert it to their own uses. The accomplishments of chemistry have made things chemical attractive to many who prey upon the gullible, and a flagrant misuse of the word "chemist" has just come to our notice.
>
> If those who sell the multitude of things now found in the modern drug stores are to be allowed to call themselves "retail chemists" then certainly those who sell drugs only should be called "retail doctors," and where dentifrices and tooth brushes are handled over the counter we shall expect to find "retail dentists."
>
> The whole thing is utterly absurd and vigorous steps must be taken to have all and sundry understand that the word "chemist" rightfully belongs to an ancient and honorable calling.—*Unidentified British Trade Paper* via *The Chemist*

Abstracts

APPARATUS, LABORATORY PRACTICE, AND DEMONSTRATIONS

A Method of Filling a Siphon Barometer. S. GOIG. *J. chim. phys.*, **27,** 452–4 (Oct., 1930).—Detailed directions are given for filling a siphon barometer. A self-explanatory illustration is included. M. W. G.

The Development of Modern X-Ray Generating Apparatus. See this title, page 1405.

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS

Instructional Material for the Small Laboratory. J. J. CONDON. *High Sch. Teacher*, **7,** 148–50 (Apr., 1931).—Methods to teach the applications of science and to create enthusiasm and interest in it are suggested in this paper. An exhibit solicited, assembled, and interpreted to the class by the students themselves has, in at least one school, been more than ordinarily successful in accomplishing these ends.

Industrial sources of exhibit materials are listed and directions for motivating students to the efforts needed in collecting and arranging it for display are given. Teachers contemplating a start toward a science museum will find helpful ideas in this paper. B. C. H.

Square Deals for Superior Students. B. C. HENDRICKS. *High Sch. Teacher*, **7,** 140–1 (Apr., 1931).—The superior student should be tomorrow's leader. Neglect for his adequate training is "nothing less than infidelity to the future." The influx into the high school of the lower quartile students that in the past were "weeded out" has caused the standards of our high schools to be lowered. The result is that the bright student is motivated to do capacity work to a lesser degree than formerly. Hence some of the best high-school talent is being wasted.

The most important task facing a teacher having superior students in his classes is that of challenging them to the best they can give. Larger schools can group these students in separate classes, but such procedure is impossible in smaller schools. In the latter, assignments may be made so as to include minimum and extended content.

Some recently published texts are arranged with minimum, extra-minimum, and superior ability levels of content for both reading matter and exercises.

"Education in America is becoming progressively more universal. . . . . Tomorrow will probably find the junior college diploma the least that is acceptable. All this means readjustment of both curriculum and administration." H. T. B.

Can the Teacher Justify His Job? F. T. SPAULDING. *J. Eng. Educ.*, **21,** 384–403 (Jan., 1931).—Secondary-school teachers generally follow some variation of the following scheme: assignments for out-of-class preparation, explaining, and testing. College teachers, in general, use the class period for delivering prepared information to students. If discussion is welcomed, the teacher usually answers the questions. The status of the classroom teacher of secondary schools and colleges is: the teacher teaches and the students learn, but the teacher teaches in such a fashion that purely mechanical devices can successfully reproduce both the method and the results of his teaching. The teacher must change this status if he is to prove himself indispensable.

The teacher must recognize: (1) that class teaching involves the teaching of a *group* of students, not a collection of individual students many times repeated, (2) that group learning involves a procedure distinctively its own; coöperative learning is accomplished in a somewhat different manner than individual learning, and (3) that the teacher's contribution must consist principally in his contribution to group learning. The essential features of group learning are: (1) recognition of a *problem* affecting the group as a whole, or which group action can more effectively solve than can individual action, (2) focusing the attention on the vital part of the problem, (3) discovery of methods for the solution of the problem, (4) selection of the method to be used, and (5) designation of certain individuals to work upon the problem, and to report back to the group as a whole. It is to be noted that there is a shift from group learning to individual learning and back again.

The merits of the plan are: (1) unity of purpose of the group as a whole, due to the recognition of a common problem, (2) the group learns not merely what the solution of the problem may be, but how to arrive at the solution, (3) responsibility of the individual to the group serves as a stimulus to action. Such a system would involve: (1) changes in the relationship of the teacher to the class, (2) changes in organization of subject

matter, and (3) changes in the formal ordering of class work. A fixed number of class meetings of definite length would not be desirable. The radical departure of the plan from the system now in use necessitates moderation in any attempt to apply it at the present time. H. T. B.

ADMINISTRATIVE PROBLEMS AND DEVICES; CURRICULA

A New Secondary School. G. WATSON. *Prog. Educ.*, **8**, 303–10 (Apr., 1931).—The following principles are involved in the new secondary school: (1) the high school is everybody's school and its methods and curriculum must be adapted to this fact; (2) these "everybodys" are exceedingly different one from another; (3) the new secondary school must serve a changing society; (4) learning is the result of activity on the part of the learner; (5) education is a continuing process. A curriculum organized in accordance with the above principles demands a considerable reorganization of the present classification of subject matter. The author suggests that the new school be organized around a Department of Health, a Department of Personal Relations, a Department of Vocations, a Department of Money and Goods, a Department of the Social Order, a Department of Recreation, and a Department on the Interpretation of the Universe. The author gives a brief description of the content of each of these departments and answers some of the probable questions likely to be raised regarding them. C. M. P.

Secondary Curriculum-Development in Los Angeles. M. E. HERRIOTT. *Calif. Quart. Sec. Educ.*, **6**, 268–86 (Apr., 1931).—Curriculum-making in Los Angeles gained nation-wide attention a few years ago through the work and writing of Franklin Bobbitt. This article reviews the progress made since that time and points out that the present program is regarded as a long-term project, whereas the former was more of a temporary "organization." The article presents the following aspects of the present program: administrative organization for curriculum-development, the services rendered in the name of curriculum-development, the curriculum-development program, and the changes effected in the curriculum. C. M. P.

The Course in High-School Chemistry: A Progress Report. W. H. LANCELOT. *North Cent. Assoc. Quart.*, **5**, 494–507 (Mar., 1931).—This is a committee report on chemistry teaching in high schools made to the North Central Association. Fourteen units have been selected. This report covers the experimental teaching done on one unit, "The Relation of Chemistry to Human Health." A complete description of the unit, with suggested bibliography, is included. Comments of the participating teachers are given.

In the same issue of this publication there appear two similar articles, one on physics and one on biology. C. M. P.

The Chicago Plan. R. M. HUTCHINS. *Educ. Record*, **12**, 24–9 (Jan., 1931).—In this article, President Hutchins describes the plan of reorganization that was initiated at the University of Chicago in September, 1930. The plan removes the graduate school, the senior college, and the junior college, and organizes the university into the professional schools and five divisions in Arts: the Humanities, the Social Sciences, the Biological Sciences, the Physical Sciences, and the College. Under the plan proposed a student enters the college where he remains until his general education is complete. No credits are given nor is class attendance compulsory. When the student shows by general examinations that he is ready to pass on, he is admitted to one of the other divisions or to the professional schools in which he can pursue advanced work, and finally obtain a baccalaureate or a Ph.D. The student progresses as abilities and interests permit, no time limit nor credit requirements being imposed. Research and scholarship will be emphasized in the new reorganization. C. M. P.

Square Deals for Superior Students. See this title, page 1400.

Practicing the Principles We Teach. F. E. SPAULDING. *Prog. Educ.*, **8**, 267–70 (Mar., 1931).—A year ago the faculty of the Department of Education of the Yale Graduate School announced a radical and comprehensive reorganization of the work of the department to go into effect in September, 1930. The results desired to achieve were two-fold mastery: "Mastery of self and of subject-matter." All "courses" in the various "fields," as these have come to be divided and subdivided following the interest or desires of instructors to set up, each for himself, some mark that will distinguish him from the crowd, have been abolished. Consequently, such things as "points," "credits," and "hours" have been eliminated. Gone, too, are all the fixed and detailed requirements and assignments, such as term papers, reports, and conventional examinations. Work for the doctor's degree has been laid out in three stages, each stage requiring a year's work. The work of the first stage is centered in the General Seminar which meets twice

a week for a two-hour period. Problems are discussed, selected, formulated, and organized. The seminar is a discussion and a questioning period for students and faculty. There are two general seminars with approximately twenty-five students in each. The students are selected on the basis of intellectual maturity and capacity for independent thinking. The students claim that they find this method "a greater incentive to independent study and thinking" than the old method of lectures and courses. The second stage, yet to be initiated, provides for specialization in all the major fields and the third stage is mainly devoted to doctoral theses. C. M. P.

Systems of Sabbatical Leaves. See this title, page 1409.

Normal Amount of Teaching and Research. See this title, page 1408.

Chemistry as a Career. J. READ. *Nature*, **127,** 567 (Apr. 11, 1931).—Professor John Read has an article on "Chemistry as a Career" in the *Alumnus Chronicle* of the University of Saint Andrews. Dr. Read condemns the tendency of certain secondary schools to carry their specialization in chemistry too far, to the exclusion of fundamental work in biology, English, mathematics, modern languages, etc. He advocates that chemistry should be built upon a basis of a well-proportioned general education and that only after fundamental chemistry courses have been taken can there be opportunity for chemical specialization. He remarks that in England it is difficult to find openings in chemical industry for men of second-class attainments or for women chemists possessing the highest qualifications. On the other hand, there is no over-production of first-class men and specialists, who have open to them various types of positions from chemical to administrative. F. B. D.

KEEPING UP WITH CHEMISTRY

The Relation of Physics to Chemistry. N. V. SIDGWICK. *Science*, **73,** 269–76 (March 13, 1931).—A discussion of the inter-relation of physics and chemistry by the non-resident lecturer in chemistry at Cornell University. G. H. W.

The Evaluation of Chemical Projects. A. D. LITTLE. *Chem. & Ind.*, **50,** 192–9 (Mar. 6, 1931).—*The 1931 Perkin Medal Address.* For all of our basic raw materials we must go back to some product of a natural chemical process. Many of the processes for using this raw material are chemical in nature. It is only to be expected that chemical industries should be of first importance among industries, and to be among the leaders in stock turnover and profits. A comparison of some of the leading American companies in these respects is made. The author also points out many of the pitfalls to be avoided by young industrial concerns. E. R. W.

The Mechanism of the Photographic Process. H. BAINES. *Chem. & Ind.*, **50,** 256–60 (Mar. 27, 1931).—The sensitive layer of the photographic plate consists of minute crystals, a mixture of silver bromide and silver iodide imbedded in gelatin. There are present sensitive nuclei, probably specks of foreign matter. On exposure to light a minute amount of the silver bromide is reduced in the neighborhood of the sensitive nuclei. The free bromine is acted upon by the gelatin leaving a permanent deposit of silver. On being developed the minute deposit of silver acts as a nucleus around which more silver deposits. For the same length of development the amount of silver formed is proportional to the intensity of the original illumination. The specific actions of different developing agents and of some fixing agents are given. E. R. W.

Organic Syntheses Facilitated by Pressure. G. T. MORGAN. *Chem. & Ind.*, **50,** 104–9 (Feb. 6, 1931).—*The Hurter Memorial Lecture.* A discussion of the application of pressure to the following industrial reactions: synthesis of the aromatic amines, alkali fusions, oxygenation, hydrogenation, dehydration, polymerization, condensation. E. R. W.

Quicksilver Mining in the United States. C. N. SCHUETTE. *Compressed Air Mag.*, **36,** 3457–61 (Apr., 1931).—Quicksilver mining in the United States was started about 1850 in California to supply the demand for the amalgamation process for the recovery of gold. At the present time the bulk of the quicksilver mined is used in the manufacture of fulminate, drugs, vermilion, and for other industrial purposes. By far the greater part of our annual production comes from ores which contain from 0.5–1% of the metal, *i. e.*, ores which furnish 10 to 20 lb. quicksilver per ton of ore. Obviously efficient operation is required to show a profit with the present price of $1.32 per pound. E. R. W.

Developments in the Electrical Industry during 1930. Research. J. LISTON. *Gen. Elec. Rev.*, **34,** 43–7 (Jan., 1931).—The results of lightning investigation showed the superior value of the overhead ground wire for transmission lines. An X-ray tube capable of using 500,000 volts was developed, and points the way for using higher voltages. Fever may be induced in the human body by the use of short radio waves. A

method for making fused quartz disks has been perfected. Disks of 11″ and 22″ have been successfully made, and it is hoped to make 200″ disks. Quartz windows, 3″ thick, have enabled diving bells to descend to a depth of 1426 ft. H. T. B.

Developments in the Electrical Industry during 1930. Radio. J. LISTON. *Gen. Elec. Rev.*, **34,** 48–54 (Jan., 1931).—Power amplifiers were developed for use with short-wave and broadcast transmitters. Apparatus suitable for the aviation industry was improved. A description and some explanation is given of the receivers placed on the market during the year by G. E. H. T. B.

Operating Data on Electrolytic Metal Production and Refining. C. L. MANTELL. *Eng. & Mining J.*, **131,** 256–9 (1931).—About 92% of the copper, 25% of the zinc, 8% of the lead, 75% of the cadmium, 83% of the silver, and probably the entire output of bismuth in the United States are the products of the electrolytic cell. Of the world's nickel production more than 30% is refined electrolytically. Metals produced by electrolytic methods are generally conceded to be of higher purity and more uniform than those produced by other methods. Tables are given to show power requirements, costs, etc. G. W. S.

Modern Alchemy in Iron and Steel. F. D. MCHUGH. *Sci. Am.*, **144,** 26–30 (Jan., 1931).—Contrary to common opinion modern sceintists have not only produced steel equal in quality to that used by medieval smiths and forgers in making the famous Damascus blades, but they have improved upon it. Scientific research has given us a variety of steel alloys, each suited to fill some particular need. Nickel, molybdenum, manganese and tungsten steels are well known. Chromium, or stainless steel, is finding extensive use in automobiles, building construction, and other uses requiring rust-proof iron. Permalloy, a magnetic nickel steel, is used extensively in telephone and telegraph cables, transformers, relays, and measuring struments. Cobalt steel has very useful magnetic properties. Konel is a new metal that is very strong and durable at high temperatures and is used in radio tube filaments. Promal is a specially treated iron, having great durability, strength, and hardness. Nitriding (heating iron at a temperature of 900–1000 degrees in anhydrous ammonia for two to ninety hours) is rapidly taking the place of case-hardening. The Byers new process of manufacturing wrought iron, the Cammen process of producing ingots, the Armco continuous rolling process, and a new process for making continuous steel strip developed by Sharon Steel Hoop Co. of Sharon, Pennsylvania, are described. Illustrated. C. M. P.

From Sugar Cane to Crystal Cube. A. A. HOPKINS. *Sci. Am.*, **144,** 106–9 (Feb., 1931).—The author traces the technical process of manufacturing and refining cane sugar. The article is well diagrammed and illustrated. C. M. P.

Cascara. T. J. STARKER AND A. R. WILCOX. *Am. J. Pharm.*, **103,** 147–75 (Mar. 1931).—This article is continued from the Feb. issue [*cf.* J. CHEM. EDUC., **8,** 1200 (June, 1931)] in which the species, distribution, growth, and medicinal value of cascara are described. Possibilities of growing cascara under cultivation must be considered because indications are that cascara bark is rapidly diminishing. To meet the demands for the bark more conservative methods must be used in peeling the bark. By figuring the average price paid for the bark during the past few years as about 8¢ a pound, the industry brings to the people of our west coast a revenue that runs into thousands of dollars. G. O.

The Indispensable Uses of Narcotics. Introduction. M. FISHBEIN. *J. Am. Med. Assoc.*, **96,** 856–7 (Mar. 14, 1931).—The amount of opium smuggled into the U. S. is evidence that physicians are not responsible for all the narcotic addiction. Since narcotics are so essential to medicine, however, it behooves the profession to reduce their use by replacement, wherever possible, with other remedies that will accomplish the desired result, so as to make unnecessary further restrictive measures. The series of articles introduced herewith is designed to present clearly the present status of the use of narcotics in medical practice. S. A. L.

The Indispensable Uses of Narcotics. Narcotics in Surgery. E. C. CUTLER AND J. W. HOLLOWAY. *J. Am. Med. Assoc.*, **96,** 857–9 (Mar. 14, 1931).—"Surgeons are concerned only with drug addiction due to cocaine and morphine. All the cases that we have seen, as well as much of the material published, lead us to look on the 'addict' as an individual with a perverted and degenerate personality, although obviously certain reservations must be made. Nevertheless, our views are rather fatalistic about such personalities. Still it behooves surgeons to share in the general and desirable effort to keep habit-forming drugs from such individuals. Cocaine needs no further comment. Its use is justified only in surface applications. As to morphine, we believe that from the standpoint of the surgeon it is the most valuable drug in the pharmacopeia, that it is essential in trauma and in certain very painful crises, that it should seldom be admin-

istered until a diagnosis can be made, and that in the preoperative and postoperative care of patients its use may be reduced by a proper study of substitutes." S. A. L.

The Indispensable Uses of Narcotics in the Practice of Medicine. F. TICE. *J. Am. Med. Assoc.*, **96,** 944–6 (Mar. 21, 1931).—For the relief of pain, morphine has no rival, and this makes it indispensable in medicine. Use of opium for its hypnotic effect alone is liable to severe criticism. In the opinion of T., opiates are indispensable or highly desirable in a variety of ailments including inoperable carcinoma, colic, cardiovascular diseases, angina pectoris, pleuropulmonary diseases. Opiates are not indispensable or are usually contraindicated in bowel diseases, spinal diseases (*tabes dorsalis*), diabetes mellitus. "With the advent of the newer local anesthetics, cocaine has lost much of its importance." S. A. L.

The Indispensable Uses of Narcotics in Obstetrics and Gynecology. J. B. DELEE. *J. Am. Med. Assoc.*, **96,** 1007–8 (Mar. 28, 1931).—Uses of narcotics during pregnancy has prevented many abortions. "During labor, opium preparations cannot be dispensed with." Special indications for narcotics are as an aid to general anesthesia, in cases of eclampsia, placenta praevia, postpartum hemorrhage. In gynecologic operations morphine is still indispensable, but it had better be dispensed with, if possible, in treatment of chronic gynecologic diseases. "For the woman suffering the pains of incurable cancer, morphine is the great savior; it should be given often and in sufficient dosage." S. A. L.

The Indispensable Uses of Narcotics. The Therapeutic Uses of Narcotic Drugs. H. C. WOOD, JR. *J. Am. Med. Assoc.*, **96,** 1140–4 (Apr. 4, 1931).—"The therapeutic uses for which opium is used may be considered under six heads: (1) locally; (2) as an analgesic; (3) as a somnifacient; (4) as a respiratory sedative; (5) as a sudorific; (6) for its effect on the intestines." Its use locally is of no value. In the other cases its use can be decreased greatly by the use of other, non-habit-forming drugs and rather detailed instructions for accomplishing this end are given. Cocaine is used to dilate pupil of eye, to shrink tissues in nose, and as a local anesthetic. While it is distinctly superior in many cases, W. warns against its habit-forming properties and discusses those cases in which less dangerous substitutes may be used. S. A. L.

The Indispensable Uses of Narcotics in Local Anesthesia. G. DE TAKÁTS. *J. Am. Med. Assoc.*, **96,** 1228–9 (Apr. 11, 1931).—A brief, clear statement of the ways in which cocaine and its derivatives should be used in local anesthesia. S. A. L.

BCG. P. DE KRIUF. *Ladies Home J.*, **48,** 8–9, 71 (Mar., 1931).—BCG is a vaccine to guard newly born babies from dying of tuberculosis. This vaccine was discovered by Calmette of the Pasteur Institute of Paris. The author traces the history of the discovery of BCG—shorthand for Bacillus Calmette-Guerin. Calmette began his experiments in 1906, using tuberculosis-infected cows as experimental subjects. Koch had previously proved that to resist tuberculosis you have got to be tuberculous! After many years of experimenting, success crowned the efforts of Calmette just as the World War broke out. The BCG vaccine must be given to babies before they are ten days old. Prior to the use of the BCG vaccine, 25 out of every 100 babies of tuberculous mothers died from tuberculosis. Now the figures are 2.4 per 100. In Holland among babies contaminated in their first year, but who showed positive tests and were given BCG, the death rate has been reduced from 52.3 to 3.8%. In France, Spain, Rumania, Russia, and Sweden the general death rate among those vaccinated is half that of those who have not had BCG. Over 500,000 babies in Europe have had BCG. In the United States where now 380,000 youngsters are known to be tuberculous; where $800,000,000 a year is spent to fight tuberculosis; where death from consumption still costs us a billion and a half a year, de Kruif predicts that Calmette's BCG, common sense, good food, and sunlight in fifty years will make tuberculosis sanatoriums as rare as smallpox pesthouses are now. C. M. P.

The Extraction, Distribution, and Action of Testicular Hormones. F. C. KOCH. *J. Am. Med. Assoc.*, **96,** 937–9 (Mar. 21, 1931).—The method of extraction given yields a product of such activity that 0.01 to 0.03 mg. daily causes appreciable comb growth in a capon in 5 days. One mg. of extract represents 12 to 18 lb. of testis tissue. "Thus far there is no indication that this product can be of any value in restoring 'vigor' to the aged or neurasthenic." An excellent review of literature is given. S. A. L.

Copper Egyptian Axehead Discovered. *Nature*, **127,** 589–91 (Apr. 11, 1931).—Mr. H. C. H. Carpenter of the Royal School of Mines, South Kensington, has recently made an examination of an Egyptian axehead. It is at least 3500 years old and has the following composition: copper, 96.9%; arsenic, 1.5%; iron, 0.7%; tin, 0.2%; the remaining 0.7% included small quantities of nickel, sulfur, and oxygen. The Brinell hardness of the axehead varied from 90 on the flat to 112 on the edge. Careful study of

the specimen leads to the conclusion that the hardness of the axehead was produced partly by alloying and partly by cold working, and is not so high as to lend support to the view that the Egyptians possessed a method of hardening copper with which we are not acquainted. F. B. D.

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

The Science of Photography. C. E. K. MEES. *Sigma Xi Quart.*, **19,** 1–19 (Mar., 1931).—There is a difference between the science and the practice of photography. The former has but recently received attention at the hands of scientists.

To the one who has not given it some attention the number of pure sciences allied to that of photography is a surprise. In such a catalog one finds physical and geometric optics, with colloid, physical, and organic chemistry. A graphic chart prepared by the author exhibits these interrelationships in this paper.

A division of the subject is made into: (1) a study of the light-sensitive substance and the changes it undergoes, and (2) the properties of the image and their relation to the light and shade in the object.

The nature of the change in the silver bromide—"usually containing some silver iodide"—is at the present time considered to be a reduction of the halide to metallic silver "which in development acts as a nucleus for the deposition of further silver produced by the reduction of the silver halide by the developer." One theory assumes that "the energy falling on the whole crystal is concentrated at a boundary between silver sulfide specks and the silver bromide and there effects the liberation of metallic silver by the release of bromine atoms."

Other topics receiving attention in this paper are: characteristic curves of photographic emulsions, relation of grain size to sensitiveness, the velocity of development, the cycle involved in tone reproduction (including a chart), printing characteristics and its effect upon tone value, sharpness of image, graininess in print or positive resolving power in photography, panchromatic and orthochromatic emulsions, the use of dyes in extending the range of spectrum photography, and the use of photography in photometry. B. C. H.

The Development of Modern X-Ray Generating Apparatus. W. D. COOLIDGE. *Gen. Elec. Rev.*, **33,** 608–14, 723–6 (Nov. and Dec., 1931).—Starting with Röntgen's early tube, step by step, the author traces the evolution of this tool of the medical profession and of the research laboratory to the most recent development, a 500,000-volt two-section tube.

Some problems encountered in its development were: preparation of a refractory metal for the target, efficient facilities for conducting the target heat away, control of the vacuum of the gas-filled tube, and the control of the focal spot of the target.

The refractory metal was found in tungsten. Its metallurgy and treatment contribute an interesting chapter in this paper.

The third problem led to the development of the modern hot-cathode tube. Some advantages of this type of tube are listed as: flexibility, stability, reduced size, direct operation from a transformer, and a longer life.

The adapting of the alternating current to X-ray tubes led to either the use of rectifiers or dependence upon the X-ray tube to do its own "selecting." It is in general found more satisfactory to give the tube outside assistance in handling rectification.

Very high voltage tubes, such as the 900,000-volt one under construction for use in the General Memorial Hospital in New York, have less need for the auxiliary rectifier. These high voltages are attained by the induction coil method rather than by transformers.

Such high-voltage construction does increase the electrical hazard and so has to be rendered safe by protective construction. Oil immersion and grounding of the secondary coil are two of the measures taken to that end.

Another improvement which greatly increases the precision of the modern tube is an automatic timing mechanism which "makes and breaks the primary circuit at zero on the voltage wave." B. C. H.

The Chemistry and Metallurgy of Beryllium. G. M. DYSON. *Chem. Age*, **24,** 228–30 (Mar. 14, 1931).—A summary of the known properties of beryllium and its alloys. Recent progress in the extraction of the metal from its ores has lowered its cost to about one-fourth of what it was a few years ago. Still it has not yet become as important a metal as it was expected to become when it was first made available in commercial quantities. E. R. W.

Silver and Its Application to the Chemical Plant. D. MCDONALD. *Chem. & Ind.*, **50,** 168–78 (Feb. 27, 1931).—This article treats of: the economic history of silver, the

occurrence and metallurgy, physical properties, chemical properties, the alloys of silver, and their industrial uses.

Silver is used in certain food industries, in industries involving microörganisms, in the recovery of certain solvents in the manufacture of acetate rayon, and in the caustic alkali industries. E. R. W.

The Evolution of Coal. H. BRIGGS. *Chem. & Ind.*, **50,** 127–33 (Feb. 13, 1931).—An interesting, not overly technical, description of the theories for the formation of coal. A short bibliography is included. E. R. W.

A List of Alloys. W. CAMPBELL. *Proc. Am. Soc. Testing Materials*, **30,** Pt. 1, 336–97 (1930); *Metals & Alloys*, **2,** 61 (Mar., 1931).—"Campbell's list of non-ferrous alloys, which has been so useful for reference, has been brought up to date, and greatly enlarged. There are about 8000 compositions listed. The physical properties of the standard and widely used alloys are given from American Society for Testing Materials specifications and from other sources. The utility of the list has hereby been vastly enhanced. It can be purchased separately from the bound volume of *Proceedings*." M. W. G.

The Extraction, Distribution, and Action of Testicular Hormones. See this title, page 1404.

HISTORICAL AND BIOGRAPHICAL

This Year's Nobel Prize Winners. O. KLEIN. *Teknisk Tids.*, **52, Uppl. A.,** 827–32 (1923).—This article contains a brief summary of the work of Einstein, Bohr, Soddy, and Aston up to the time they received the Nobel prizes. The relations between the ideas of the four men are brought out. Portraits of each included. M. W. G.

Einstein, Bohr, Soddy, and Aston. See **This Year's Nobel Prize Winners** above.

Professor Einstein at the California Institute of Technology. See this title, page 1410.

Dr. Henry Leffman. *Am. J. Pharm.*, **103,** 113–46 (Mar., 1931).—This number of the *Journal* is a memorial to Dr. Henry Leffmann (1847–1930) whose contributions to chemical literature have been extensive. As a "chemico-legal" and "medico-legal," he is a shining example of what a scientific expert should be. Few men have labored more zealously to give chemistry a professional standing. The addresses before the Leffmann memorial meeting published in this issue exemplify the high regard in which Dr. Leffmann lived in the hearts of his fellow scientists. G. O.

The Scientific Works of P. A. Levene. O. FOLIN. *Chem. Bull.*, **18,** 99–101 (Apr., 1931).—This paper is largely devoted to Levene's work upon the proteins. His first important paper is said to have been published in the *Berichte* in 1909. In the twenty-odd years since, he has published over four hundred papers, the most noteworthy of which have been upon proteins and their composition. In addition to a study of the proteins he has also worked upon the lecithins. The occasion of the paper under abstract was the recent conferring upon him of the Willard Gibbs Medal by the Chicago Section of the American Chemical Society. B. C. H.

Gay-Lussac and Thénard. See **The Metals Boron and Aluminum. "A Classic of Science,"** below.

Petit and Dulong. See **Specific Heats and Atomic Weights. "A Classic of Science,"** below.

Faraday Celebrations 1931. See page 1442.

Royal Institution Meeting Devoted to Joseph Priestley. See page 1446.

Copper Egyptian Axehead Discovered. See this title, page 1404.

The Metals Boron and Aluminum. "A Classic of Science." GAY-LUSSAC AND THÉNARD. *Sci. News Letter*, **19,** 171–3 (Mar. 14, 1931).—This translation from the original French article describes the experiments which these chemists used to obtain boron and aluminum by reduction of their compounds with metallic potassium. H. T. B.

Specific Heats and Atomic Weights. "A Classic of Science." PETIT AND DULONG. *Sci. News Letter*, **19,** 230 (Apr. 11, 1931).—This translation from the French gives the considerations which lead to the method of determining specific heats used by these authors, a description of the method, the data secured, and the deduction of the law that atoms of the elements have the same heat capacity. H. T. B.

EDUCATIONAL MEASUREMENTS AND DATA

Teacher-Conducted vs. Pupil-Conducted Experiments in High-School Chemistry. T. L. NELSON. *Calif. Quart. Sec. Educ.*, **6,** 258–61 (Apr., 1931).—The problem was to determine whether high-school chemistry students learn more chemistry, as measured

by a standardized test, if they conduct their own experiments than they do if the experiments are demonstrated before the class by the instructor. The experiment was conducted in the Yuba City Union High School during the second semester 1929-30. There were fifteen pupils in the pupil-conducted laboratory class. Both groups were given an Otis Intelligence Test and a Powers Chemistry Test at the beginning of the semester. The demonstration group made a mean intelligence score of 46.8 and a mean chemistry score of 13.8. The laboratory group made a mean intelligence score of 41 and a mean chemistry score of 16.4. Thus one group had a higher initial intelligence score and the other group a higher mean chemistry score. At the conclusion of the experiment the demonstration class made a mean gain of 2 points over the pupil-conducted experimental group. The author comes to the conclusion that the demonstration method is more effective than the laboratory method and recommends that it be more widely adopted. C. M. P.

Causes of Failure and Success in School. J. MILLER. *Educ. Method*, **10**, 327-33 (Mar., 1931).—The author presents his findings in a study involving 1558 pupils in the Wilkes-Barre, Penna., schools. The following seemed to be factors in determining success and failure: (1) language factor; (2) quality of speech; (3) reading; (4) conduct; (5) attendance; (6) grades repeated; (7) physical defects; (8) personality; (9) personal appearance; (10) home conditions; (11) group instruction. C. M. P.

Circumstantiality as a Factor in Guessing on True-False Examinations. I. H. BRINKMEIER AND N. KEYS. *J. Educ. Psychol.*, **21**, 681–94 (Dec., 1930).—The authors selected certain true-false items found in series of tests which had been used previously in a nation-wide prize contest. The test was submitted to three classes of tenth-, eleventh-, and twelfth-grade pupils at the University High School, Oakland, California, and to a group of one hundred senior and graduate students in the school of education of the University of California. Investigators have found that certain words or phrases often serve as "specific determiners." For example, statements containing the words *all, always, only, no, never, none* are more often false, while statements qualified by *most, some, probably, may, often* are more often true. The authors eliminated such items as these. They selected fifty true statements found in actual examinations but regarded as likely by reason of their circumstantial nature to be marked "true" whether known by the pupil or not. Another list included twenty-five factitious statements, false or referring to imaginary persons or circumstances, but phrased with circumstantiality similar to the fifty true statements. Results showed that guessing taking place in the average true-false examination is much greater than is commonly realized. Many statements are recognized as true by their form and nature, apart from any knowledge involved. Such items add nothing to the value of the test since they do not discriminate between the pupil who is well informed and the one who is merely test-wise or shrewd at recognizing surface indications in the statements themselves. C. M. P.

Conclusions Derived from Experimental Studies on the Value of Supervision. G. C. KYTE. *Educ. Method*, **10**, 403–7 (Apr., 1931).—The author presents the conclusions which have been reached from experimental studies on the value of supervision. Approximately seventy research studies have been undertaken in this field during the past decade. Four general conclusions based on these studies are: (1) supervision contributes significantly to the improvement of teaching and the facilitation of learning; (2) each type of supervisory officer employed in the school system can contribute efficiently to the improvement of teaching and of learning through his supervisory activities; (3) careful planning, organizing, and carrying on of supervisory activities are essential to the efficient attainment of the desired goals of supervision; (4) appraisal of supervision is a vital, scientific procedure which must find a regular place in the work of every supervisory officer. Improvement in pupils' achievement occurs in every subject which is given sound supervisory attention. The progress of children through the grades is improved by means of constructive supervision. Supervision definitely influences the professional growth of teachers and the more direct the supervisory help becomes, the greater is the improvement effected. The individual supervisory conference is somewhat more effective than the supervisory teachers' meeting. Supervisory planning must be done soundly and carefully; supervisory procedure must be carried on wisely and thoughtfully; and supervisory activity must be submitted to intensive, scientific appraisal regularly and frequently. C. M. P.

THE PHILOSOPHY OF EDUCATION

The Unintellectual Boy. F. WINSOR. *Atlantic Mo.*, **147**, 487–96 (1931).—This article contains a discussion of education by the secondary school, its relation to college education, and its function of preparing its pupils for their future position in society.

The idea that a college education is desirable for everyone is untenable. The public, therefore, should be made to understand that individuals differ as widely in their educational needs as in their physical appearance; hence it is no disgrace not to be a college man. Higher education demands of its votaries independent initiative, insatiable curiosity, a passion for truth reinforced by the straight thinking required to recognize truth, and sound methods and habits of work. So far, then, as secondary education is training for life and living, it must take account of the individual's vocation, his civic relations, his family responsibilities, and the recreative occupations of his free time. If, then, secondary education should train its pupils for these four activities of a man's life and if the methods were such as to secure the constant practice of straight thinking which is the vital point for college preparation, secondary education would more nearly fulfil its whole function. W. suggests ways for accomplishing this end. G. W. S.

Too Much Knowledge. See this title, page 1409.

The Chicago Plan. See this title, page 1401.

Practicing the Principles We Teach. See this title, page 1401.

Two Ways of Improving the State Universities. See this title, page 1410.

The Relation of the University to Problems and Practices in Education. See this title, page 1409.

PROFESSIONAL

Ethics in the Teaching Profession. *Research Bull. Natl. Educ. Assoc.*, **9**, 1–89 (Jan., 1931).—The introduction enumerates the causes of growing interest in professional ethics, the value of codes of ethics and their educational implications. Part I discusses instruction in professional ethics and the current practices in the schools of eight professions. Part II discusses standards of professional conduct among teachers. There are chapters dealing with: (1) general principles of conduct; (2) standards of conduct in relations with pupils, parents, and community; (3) standards of conduct in relations with associates; (4) standards of conduct in relation to the profession; (5) standards of conduct in securing and terminating employment; (6) standards of conduct in connection with teachers' agencies. Specific cases are cited and complete bibliographies are included. The code of ethics of the National Education Association is included. C. M. P.

Can the Teacher Justify His Job? See this title, page 1400.

The Improving College Professor. C. D. CHAMPLIN. *Phi Delta Kappan*, **13**, 171–4 (Apr., 1931).—The author is an optimist as the title indicates. He supports his thesis by citing eighteen different types of publications which give evidence that there is a leaven working in college faculties toward better teaching.

He also cites studies and investigations which bear directly upon the teaching problems of the college teacher. Ten titles of such studies are named.

Who is the most desirable college professor? This finds answer in two distinct catalogs of preferred characteristics as set up by two different students. These lists are quoted from *School & Society*.

Changes in college administration and policy that are conducive to better teaching are described and methods of classroom procedure which find most approval are enumerated.

Ten answers to the question "Why is college teaching poor?" are given and as an antidote to the maladies of these poor teachers fifteen suggestions "to the younger members of the faculty" are volunteered. And finally what to expect as an index of classroom success is set forth in a decalog of terse well-phrased objectives. B. C. H.

Normal Amount of Teaching and Research. T. W. BALDWIN. *Bull. Am. Assoc. Univ. Profs.*, **17**, 213–9 (Mar., 1931).—To what extent may a professor sell his services and time to another institution than the one upon whose faculty he serves? Should an institution control the entire service time of its teachers? Would it be desirable if every institution salaried its teaching staff so well that there could be no attraction in extra-institutional service calls because of their remuneration?

These are some of the problems considered by the chairman of Committee T of the American Association of University Professors. In this report, he says, for his committee, "The faculty should be an effective part of the great coöperate triumvirate; trustees, executives, and faculty."

He repeats from a former report, "Probably the most practical solution will be to set a fair teaching load to include all phases of the teaching activity: and then to insist that the remainder of the teacher's time is his to do with absolutely as he pleases."

The weighting of lecture time against laboratory time in making up the sum total

of the science teacher's teaching time service has not yet been standardized. This deserves attention. B. C. H.

Systems of Sabbatical Leaves. O. J. CAMPBELL. *Bull. Am. Assoc. Univ. Profs.*, **17**, 219–34 (Mar., 1931).—This paper is a committee report of the Association. Findings are a summary from data gathered by a questionnaire sent to "all institutions on the accredited list of the American Council of Education."

The committee found: that the system most commonly used, the "normal system," is to give the sabbatical leave to men of professional rank and that it carries full pay for one-half year or half-pay for a full year's absence. Many institutions include all faculty members above the rank of instructor in the provision, however. The period of service prerequisite for eligibility to sabbatical leave seems to be highly variable in spite of the implications of the name.

In general it seems that administrators are practically unanimous in favor of the adoption of the practice of such leaves, especially for travel and study.

Teaching adjustments made necessary by such absentees are usually made in the department involved.

The committee recommends that the university should not look upon such leaves as primarily advantageous to them by reason of better service from the returned teacher. Productive scholars should receive preferred treatment in the length of their leaves.

A half year on full pay should be considered preferable to a full year on half pay. B. C. H.

Too Much Knowledge. A. B. CRAWFORD. *Educ. Record*, **12**, 144–59 (Apr., 1931).—We have an undigested excess of present knowledge. Our powers of absorption have failed to keep pace with our machinery of production. Scholarship once implied the ability to consider all things in perspective. A man must now be a "productive scholar" or be classed as none at all; that is, he must not only make his special discoveries, but also be sure to get them into print regularly. The author laments that productive scholarship which finds its highest expression, not in publication, but in continuously stimulating classroom exposition is too often neglected. The reasons are that published material is tangible and concrete while the results of teaching are difficult to appraise. The rapid expansion of knowledge has changed the academic concept of scholarship, transforming its earlier and honorable estate into a modern specialized counterpart. Academic advancement depends too much upon the amount of one's publications rather than upon the fertility of his teaching. Too often it is first, teaching second. Intellectual curiosity marks the true teacher. He is not interested in mere publication for its own sake, irrespective of whether he has anything to say. He balks at pursuing research at the expense of what he considers his first obligation to the university—effective teaching. He has a quaint conviction that when he is doing research he is working primarily in his own interest. He believes that his students have first call. Clever is he who early establishes his reputation as a scholar, for anything thereafter that he produces must, by definition, be scholarship. His investigations are apt to be so specialized that there are few who can call their real worth in question. Research activities and their resulting shaping of courses and curricula and faculty appointments must not be allowed to dominate the colleges, as they have been doing, if the colleges are to carry out the purposes for which they exist. C. M. P.

The Relation of the University to Problems and Practices in Education. R. G. SPROUL. *Calif. Quart. Sec. Educ.*, **6**, 123–32 (Jan., 1931).—This is a résumé of the inaugural address of President Sproul of the University of California. Education should provide many highways of varying grades. We are in need of developing more intelligent standards. Traditions of the Middle Ages are still influencing education. Independent thinking should be the main objective of the university. "Under present conditions, we have the strange anomaly of teachers being judged not on their ability to teach but on their research output, and investigators being forced to devote valuable time to teaching that might be given to advancing the frontiers of knowledge. As a result, men who might be good teachers if they were encouraged by the hope of future advancement, are drifting about in laboratories with a couple of test tubes in their hands making themselves useless in a most arduous and time-consuming way, and men who might be good investigators are wearing out their patience and their students in a vain effort to expound and to inspire. The criterion of the teacher should be ability to teach and of investigators to investigate, and neither look down upon the other so long as each is doing his job well. As it is, the good teacher, looked down upon by his colleagues because he is not producing each year a certain amount of scholarly pep, is frequently made so miserable that he gets out of academic life." C. M. P.

Chemistry as a Career. See this title, page 1402.

CONTEMPORARY NEWS AND COMMENTS IN CHEMISTRY AND EDUCATION

Professor Einstein at the California Institute of Technology. *Science*, **73**, 375–81 (Apr. 10, 1931).—Addresses at the dinner in his honor. G. H. W.

Two Ways of Improving the State Universities. L. D. COFFMAN. *Educ. Record*, **12**, 3–13 (Jan., 1931).—The civilization of America is built from the natural resources of America. These resources of rich soil, abundant forest, coal, copper, and iron mines have been largely exploited. However, from them we derived the funds to establish and maintain our standards of living, our forms of institutional life, including education. Now we face a new situation. With these resources largely exploited, how can we maintain and advance the civilization we have established? Endowments of private colleges and universities far exceed those of state colleges and universities. These have been made possible largely because of alumni donations, but in addition great foundations have financed and endowed certain private institutions. President Coffman says 91.5% of the contributions of great foundations have been given to private institutions and only 8% to state institutions. Steps need to be taken for the establishment and growth of state endowments for state universities. Texas has a state endowment which will amount to two hundred millions of dollars. Also state universities need to get together and allocate certain functions between the institutions. For instance, Minnesota University might become a great center for the Scandinavian cultures, Michigan for Romance languages, Wisconsin for dairying, Washington for forestry, Idaho for mining, and so on. C. M. P.

The Chicago Plan. See this title, page 1401.

The Course in High-School Chemistry: A Progress Report. See this title, page 1401.

Practicing the Principles We Teach. See this title, page 1401.

The Institute of Physico-Chemical Biology in Paris. See page 1412.

Preliminary Announcement, Buffalo Meeting of the A. C. S. See page 1422.

The High-School Teachers of New York State. See page 1423.

World Federation of Education Associations. See page 1424.

The Final Meeting of the Chemistry Teachers' Club of New York City. See page 1425.

Conference for Investigators Interested in the Chemistry and Physiology of Plants. See page 1426.

Conference of International Student Service. See page 1427.

New Bulletins on Operation of Colleges and Universities. See page 1427.

New Laws for America's Schools. See page 1428.

All College Sophomores May Be Given Uniform Examination. See page 1429.

The Thirteenth Chemical Exposition. See page 1430.

Students' Course at Chemical Exposition Highly Successful. See page 1433.

Emblem of Chemical Abstracts. See page 1434.

Last Missing Chemical Element Detected by New Method of Analysis. See page 1435.

Science Penetrates Structures of Wood and Rubber. See page 1436.

Chemicals Send Yeast to Sleep. See page 1436.

Atoms Declared Not Dependable. See page 1437.

Lifeless Drops May Act Like Living Cells. See page 1438.

Studies Upset Theories of Immunity to Disease. See page 1439.

Incurable Tropical Disease Yielding to Science. See page 1440.

Insanity a Matter of Colloid Chemistry. See page 1440.

Atoms Combine in Sun's Atmosphere. See page 1441.

Carbon Monoxide Made Non-Poisonous by Famous German Scientist. See page 1441.

Zinc Refined by New Process. See page 1441.

Faraday Celebrations 1931. See page 1442.

Royal Institution Meeting Devoted to Joseph Priestley. See page 1446.

Huge Electro-Magnet Installed at University of Leiden, Holland. See page 1446.

Samuel Wilson Parr. See page 1447.

Hudson Receives Hillebrand Prize. See page 1447.

Mechanist Philosophy Upheld by Levene, Gibbs' Medalist. See page 1448.

Dr. Hopkins Lectures on Purification of Rare Earths. See page 1449.

Award of J. T. Baker Chemical Co.'s Analytical Fellowship, Eastern Division. See page 1449.

Award Not Made in Mustard Gas Contest. See page 1449.

Millikan Hails Radio as Friend of Freedom. See page 1450.

Dr. Luckhardt Speaks before Gorgas Medical Society, University of Alabama. See page 1451.
South Dakota Academy of Science. See page 1451.
New Director of Research for Central Scientific Company. See page 1451.
Louisiana Section A. C. S. Devotes Meeting to Study of Chemical Education Problems. See page 1451.
American Association of Physics Teachers. See page 1452.
Chemical Exposition Meeting of the New York Professional Group of Alpha Chi Sigma. See page 1452.

California Scientist Defends Human Intelligence. Is man a rational animal? A negative answer to that question, which has become increasingly fashionable in certain schools of psychology, is vigorously combated by Prof. William E. Ritter of the University of California and first president of *Science Service*. Prof. Ritter's article answering the question in the affirmative appeared in a recent issue of *Human Biology*.

To deny specific intelligence to man, Prof. Ritter says, is to deny that the great development of the forebrain, unique possession of the human species, has any significance whatever. It even amounts to denying that man goes upright on his hind legs and can use his forelimbs in more versatile fashion than any other animal.

After attempting to find a definition of intelligence by experts on the subject, and finding the experts all tangled up in differences of opinion with each other, Prof. Ritter undertook to make his own definition. He says:

"Intelligence is that attribute of which some animal species have become possessed through the long, hard course of evolution, in virtue of which the individuals may avoid doing fool things if they really desire and really try to avoid them."

Prof. Ritter opposes the old notion that animals depend entirely on "instinct" which is always "unerring." Animals, he says, do fool things just as human beings do them. To the extent that their mental makeup allows them choice, they sometimes make the wrong choice. He cites the case of California woodpeckers that had plenty of acorns stored up, yet raided orchards full of ripening almonds—and got themselves shot as thieves by the outraged owners.

Man, with a far better developed brain than any of his lesser kinsfolk, has a more flexible and powerful apparatus for the functioning of intelligence. He has a wider choice; he can do more "wise" things as well as more "fool" ones. His intelligence, his rationality, means that he has the ability to consciously guide his actions in accordance with the well being of himself and his own kind.—*Science Service*

Chemistry Seen as Aid to Business Revival. Chemical industries will make contributions to our modern industrial life which will help the revival of prosperity, Dr. A. D. Little, consulting chemist of Cambridge, Mass., predicted in his address upon the occasion of receiving the Perkin Medal, one of chemistry's highest awards.

"Advances in chemistry react on every industry," he said, "while conversely every progressive trend in other industries makes new demands on chemistry."

"We may look with confidence to the chemical industries for contributions which should go far toward supplying the stimulus essential to the revival of our prosperity."

Dr. Little predicted a phenomenal development in the plastics industry and in materials of construction adapted to the mass production of dwelling houses. He pointed out that new chemical agents are beginning to replace water in heating and power equipment, new products from water gas and from the waste gases of oil refineries are in sight, and even new foods are in prospect. Meanwhile, he declared, sulfuric acid, chlorine, and soda remain commodities as basic as steel.—*Science Service*

Contemporary News in Chemistry and Education

THE INSTITUTE OF PHYSICO-CHEMICAL BIOLOGY IN PARIS

MADAME Y. KHOUVINE, INSTITUT DE BIOLOGIE, RUE PIERRE CURIE, PARIS, FRANCE

In a previous article* the author described the establishment, through a gift of BARON E. DE ROTHSCHILD, of an Institute of Physico-Chemical Biology in Paris, and gave a short account of the members of the staff selected at that time. Since then all of the laboratories have been installed and all are now in full operation.

BARON E. DE ROTHSCHILD

The Institute was officially opened at the end of January by the Minister of Public Instruction and by the Board of the University in the presence of Baron Rothschild. PROFESSOR JEAN PERRIN and the MINISTER OF PUBLIC INSTRUCTION publicly thanked the Baron for his generous gift; then the visitors were permitted to inspect the Institute. Every one could admire the equipment, so modern and so perfect in every detail—every facility and the most modern apparatus have been put at the disposal of the workers. Finally lunch served in the library brought together the guests, who were happy to congratulate the organization on this magnificent work.

Some details concerning the buildings as a whole and the distribution of the departments follow.

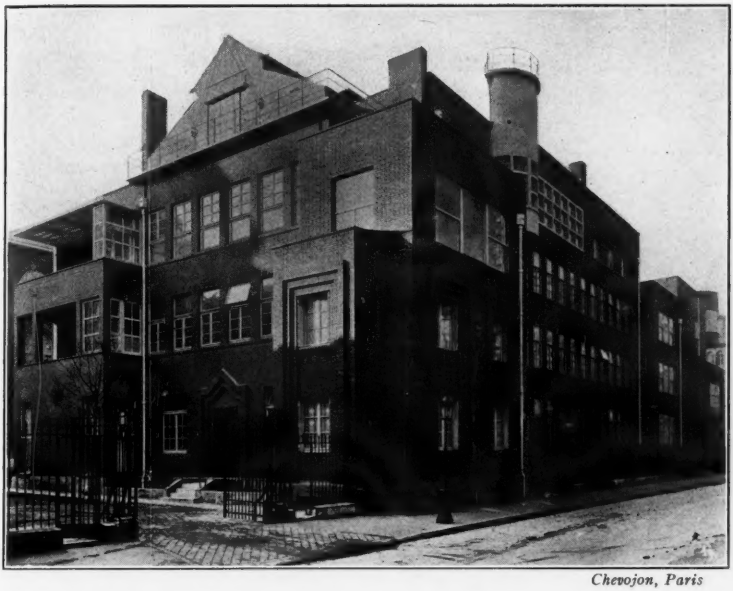
Buildings

The architects, Germain Debré and Cristi, drew the plans and arranged all details of interior installations in close collaboration with the director and the heads of departments of the Institute. They have supervised together the entire execution of the plans.

The plot on which the Institute has been erected is located on the rue Pierre Curie and has an area of 1750 square meters. Areas of 720 and 157 square meters have been reserved for the principal building and for the physiology building, respectively. These two buildings are separated by a driveway 7.5 meters wide and are joined at the third-floor level by a covered footbridge. The Institute is separated from the street by a planted border and an English court. A garden separates it from the Henri Poincarè Institute.

As there is reason to fear the presence of ancient quarries and as the good earth resembles nothing so much as a hollow shell of clay of varying thickness, eighty-two concrete foundation shafts have been sunk to depths of 6 to 12 meters—fifty-nine for the principal building and twenty-three for the physiology building. An old operating shaft of tile from which

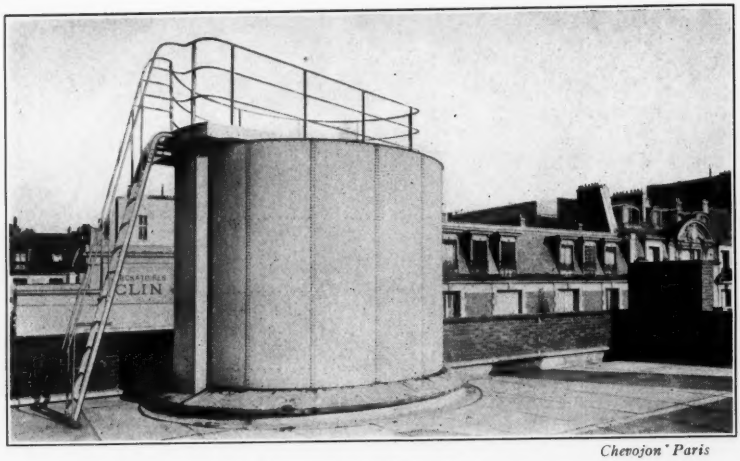
* KHOUVINE, "The New French Institute of Physico-Chemical Biology," J. CHEM. EDUC., 7, 1051–7 (May, 1930).



Chevojon, Paris

Chevojon, Paris

VIEWS OF THE INSTITUTE FROM RUE PIERRE CURIE AND THE GARDEN



Chevojon, Paris

TERRACE AND HELIOSTAT

Gallo-Roman debris had been recovered has been utilized for the construction of a constant-temperature chamber.

The walls of the buildings are of millstone covered with granite for the basements and for the upper stories they are of red brick. The roofs are terraced. One of the terraces is covered

Chevojon, Paris

LIBRARY

Chevojon, Paris

Chevojon, Paris

CHEMICAL LABORATORIES

Chevojon, Paris

A PHYSICS LABORATORY

with earth and is being used as an experimental garden. On another the heliostat has been erected.

To avoid as far as possible the transmission of vibrations, the floors are constituted of girders and plates in reinforced cement with iron joists placed crosswise. Several stationary piles deeply sunk in the ground are specially constructed to avoid the transmission of vibrations.

General Arrangement of the Interior

The floor in the workrooms of the physics hall is parquetry, and in all the others of tile. The walls in the former are in plaster, white or black, and in the chemistry and biology halls, of glazed white tile.

Chevojon, Paris

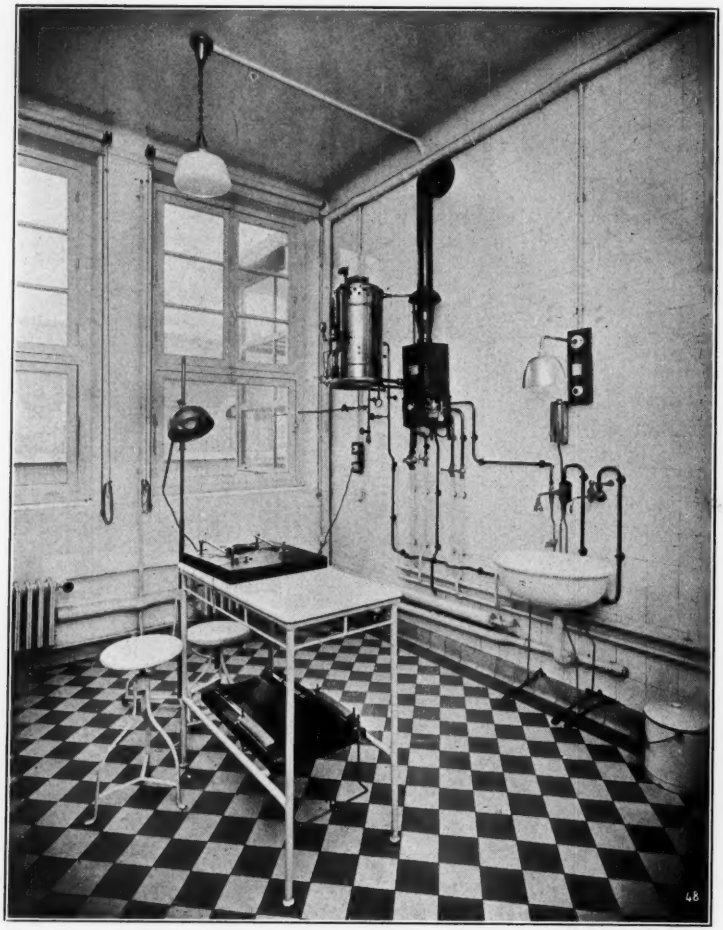
ONE OF THE BIOLOGICAL CHEMICAL LABORATORIES

All the laboratories are as well lighted as possible in the daytime by large windows, in the evening by central lights so powerful that there is no need of local lighting on the stands. All have hot and cold water, compressed air, gas, and electricity of various voltages and amperages. An interior telephone system unites all the laboratories, and, finally, there are two elevators.

General Facilities

In the Basement: A constant-temperature laboratory, a large machine shop, a glass-blowing shop, a machine room reserved for heavy apparatus (large centrifuges, hydraulic press, grinder, etc.); the supplies of glass and chemicals with an isolated room reserved for dangerous materials, a garage for six cars, boiler room and the rooms for electrical transformers and accumulators. These last merit some details. The total power of the electric installation is 100 kilowatts. The transformer room contains a group giving a current of 200 to 250 amperes at 110 volts and a two-phase alternator of 500 cycles. In the battery room there is a storage battery capable of furnishing 1000 ampere-hours of current at 110 volts; three batteries with a capacity of 180 ampere-hours at 110 volts; one giving 180 ampere-hours at 2 to 10 volts; and two large batteries of small cells furnishing 3200 volts. The electrical distribution is assured by twenty independent lines. Each laboratory has at its disposal alternating current of 110 and 220 volts, and direct current at voltages from 2 to 3200.

On the Ground Floor: A secretarial room and a large assembly room with library. There is also on this floor a porter's room and on the fourth floor, technicians' quarters opening on a large terrace.

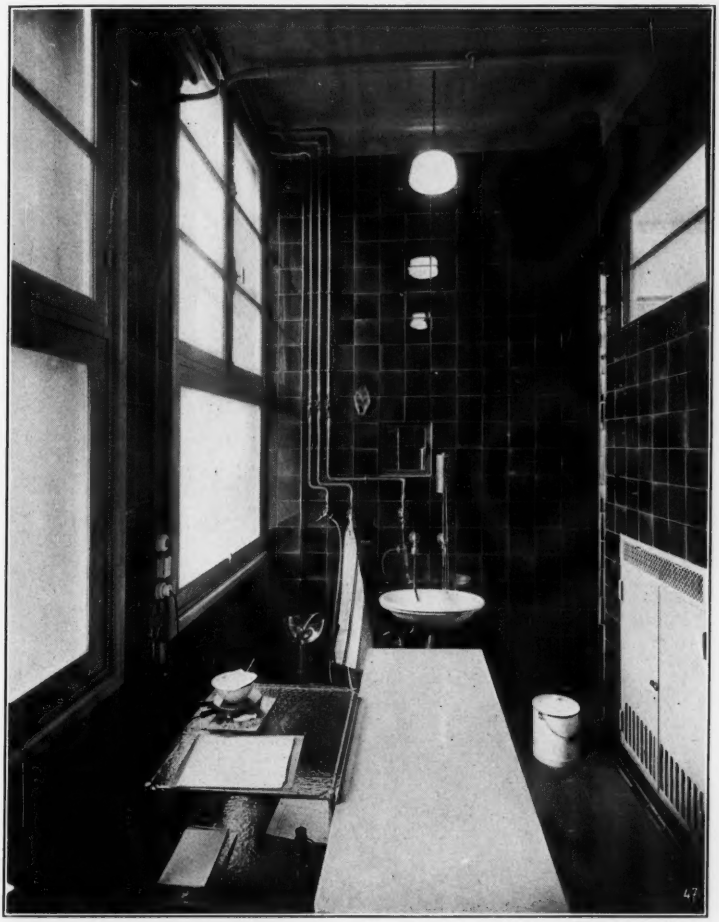


Chevojon, Paris

ROOM WHERE TISSUE SPECIMENS FOR CULTURE ARE TAKEN

Physical Department: This has an area of 650 square meters. In the basement are installed all the X-ray devices. The whole ground floor is occupied by eight physics laboratories. In two of these are the stationary piles for galvanometers. On the fourth floor, a large room for actinology, with terrace, is surmounted by a movable turret containing the heliostat. Projectors furnish powerful artificial light.

Chemistry Department: This occupies an area of about six hundred fifty square meters. In the basement, three rooms are reserved for microchemistry and the microbalances are placed on stable piles. All the second floor is reserved for the chemistry department.



Chevojon, Paris

INOCULATION ROOM FOR TISSUE CULTURE

Three large laboratories, a balance room, a covered terrace for open-air operations, a photography room, and a lavatory compose the general and organic laboratory department. For biological chemistry, there are two large laboratories, a covered terrace, a laboratory for the study of fermentations and a special room for autoclaves and thermostats. A large laboratory is reserved for the study of colloid chemistry. All the chemistry laboratories have tables and work benches of glazed lava.

The physics laboratories and those for general and organic chemistry have besides wall conduits for gas and electricity, conduits mounted on small beams transversing the laboratories, and per-

Chevojon, Paris

ROOM FOR THE SMALL ANIMALS

mitting the attachment at all parts of the room of temporary connections. The encumbrance of floor-space is thus avoided.

Physical Chemistry Department: Five laboratories are equipped in similar fashion.

Biology Department: This covers 1500 square meters and comprises the laboratories of biophysics, biochemistry, experimental cytology, animal and vegetable physiology.

Biophysics uses two large laboratories, one for physical measurements, the other for physical chemistry, a chemistry laboratory, an optics room, and a dark room. These are equipped like the physics and chemistry laboratories.

The Experimental Cytology and Histophysiology departments have a chemistry room, a room for microscopic observations, a dark room, and a room for photography. For the culture of tissues a room has been especially fitted out for sterilization, a room for aseptic operation for taking samples of tissues, and three small inoculation rooms. The last are lighted by double windows to prevent the entrance

Chevojon, Paris

Chevojon, Paris

OPERATING ROOMS

of dust. The walls are finished in neutral-colored glazed tile. The work benches are likewise of dull ceramic ware, the tables are of lava and there are pipings of sterile water.

Vegetable Physiology comprises two greenhouses separated by a laboratory, two small gas-analysis laboratories, and the garden on the terrace. One greenhouse is exposed to the north and the other to the south; they are constructed of uviol glass.

The Animal Physiology Department occupies the whole physiology pavilion. In the basement are the kitchens for the animals, the crematory, and various stores. The ground floor is given over to the animals. All the sections are well lighted, the floors are of tile, the walls and ceiling of glazed tile so that they may be washed with a hose.

For dogs there are five cells and one small room containing two cells separated from the others. Each communicates by a trapdoor with a little yard where the dogs exercise. The kennels have been designed to make them as quiet as possible. The windows are double and the walls are built of sound-proof materials. A powerful ventilator renews the air twenty times an hour and this prevents bad odors. Three rooms in which the temperature can be maintained constant to about one degree are reserved for small animals and two for those of medium size. In one of the rooms there are a froggery, a terrarium, and several aquaria. It should be added that in the garden of the Institute there is a basin of running water and a poultry house.

On the second floor of the pavilion there are three physiology laboratories and a large physiology operating room. Large windows on the north and south light it during the day and in the evening illumination is assured by diffused lighting fixtures without shades. In this physiology room, not only ordinary operations but also aseptic operations can be performed, since an annex to the room contains sterilization apparatus and the room contains washstands with sterile water.

On the Third Floor is a laboratory for physiological chemistry, in which the hoods are ventilated by air injection to guard against the attack of sulfo-nitric fumes.

On the Fourth Floor is the department of aseptic operations. It contains a room for the preparation of animals with large bathing tanks, and a dryer; a sterilization room; one operating room with shadowless lighting and built like a room for human operations; and finally a constant-temperature post-operation room in which the animals are cared for after operations.

* * *

Such are the chief characteristics of the Institute of Physico-Chemical Biology. Thanks to the generosity of its founder, here is realized an Institute completely equipped with the most modern facilities, and in which biological research can be pursued with means which are often lacking in France. May the gratitude of all researchers be given to Baron E. de Rothschild.

PRELIMINARY ANNOUNCEMENT, BUFFALO MEETING OF THE A. C. S.

Program

The 82nd meeting of the American Chemical Society will be held in Buffalo, N. Y., Aug. 31–Sept. 4, 1931. Monday of convention week will be devoted in the morning to a meeting of the Council and in the afternoon to a general program of papers describing some of the new tools of research. The remaining sessions on Tuesday and Wednesday will be in charge of the various Divisions.

On Tuesday morning the program of the Division of Chemical Education will feature a joint symposium with the History of Chemistry Division, on "The History of Chemical Education in America." It is planned to make this symposium a memorial to Edgar Fahs Smith who was the first chairman of this Division

ten years ago, and who was also chairman of the Division of History of Chemistry. The symposium program will consist of the following invited papers:

1. L. C. NEWELL, Period up to 1820.
2. C. A. BROWNE, Period from 1820 to 1870.
3. HARRISON HALE, Period from 1870 to 1914.
4. F. B. DAINS, Period after 1914.

The semi-annual Division luncheon will be held Tuesday noon. Wednesday morning will be devoted to a meeting of the Senate and to meetings of standing committees, while the afternoon program will be limited to papers on Visual Aids in Chemical Education. Miscellaneous papers will be assigned to the Tuesday afternoon and Thursday morning sessions. The annual business meeting will be held at the close of the latter.

Exhibits

High-school classes everywhere are invited to send exhibits to the Buffalo meeting. A prize of $10.00 is offered by the Division for the best one submitted. Free space will be reserved on request to the *Local Secretary* of the Division, but each exhibitor must assume all costs of packing, transportation, breakage, and loss.

Papers

Papers for the symposium "The History of Chemical Education in America" and "Visual Aids in Chemical Education" will be by invitation. Authors of miscellaneous papers are earnestly requested to coöperate as follows:

1. Submit as soon as possible the titles of proposed papers, together with abstracts in duplicate and an estimate of the minimum time required, exclusive of discussion. It is the seasoned opinion of members of the Division that, since the time is limited, an author should read only an abridgment of his paper, comprehensive enough to stimulate discussion, reserving the complete paper for publication.

2. The name, address, and professional connection of each co-author must accompany the title.

3. The complete manuscript and abstracts must reach the *Secretary* prior to July 15 in order to be included on the Buffalo program. Papers received after this date will be held over, with the authors' consent, for a subsequent meeting.

4. Organize significant features on slides, films, or in mimeographed form for distribution at the meeting. These devices enhance the value of any paper. However, the amount of material on any one slide should be strictly limited.

5. Do not send in a title unless you expect to be present to read your paper.

By vote of the council of the A. C. S., papers by American chemists who are not members of the A. C. S. shall not appear on the program unless they be joint papers with Society members and no paper may be presented at a meeting unless the title has been printed in the final program. Papers read before the Division become the property of the Society, and, if acceptable for publication, will appear later in the JOURNAL OF CHEMICAL EDUCATION. No paper already submitted for publication in other journals should be offered for the program.

R. A. BAKER, *Secretary*
College of the City of New York
17 Lexington Avenue
New York, N. Y.

THE HIGH-SCHOOL TEACHERS OF NEW YORK STATE

Approximately 75 per cent of all high-school teachers in the state are college graduates, according to a study made by the Educational Research Division of the New York State Department of Education and reported in a recently published department bulletin, "Study of the High-School Teacher in New York State," by DR. WARREN W. COXE, director of the Educational Research Division, and DR. WAYNE W. SOPER, associate in the Educational Research Division. The bulletin, as summarized in *The Bulletin to the Schools*, points out

many facts in which, according to DR. GEORGE M. WILEY, assistant commissioner for secondary education, the state may well take pride, but at the same time it indicates many shortcomings in our teacher-training program. The facts presented are for different types of communities and for the teachers of each type of subject.

The study shows that 91.2 per cent of all high-school teachers in the state were graduated from high school; 18.8 per cent are normal school or city-training-school graduates; 55.6 per cent have taken summer and extension courses; 15.7 per cent have graduate degrees.

Under the item of general training of teachers in each subject group the study shows that for all teachers 10 per cent more majored in college in the same subject that they now teach than did not. Under the item of professional training the report declares that "there is considerable evidence to support the contention that professional training among high-school teachers of each subject is of a meager and irregular character." On the whole, less than 3 per cent of the teachers of the different subjects have a college major in education.

The teaching experience of teachers was considered from two aspects: (1) teaching experience in present position; (2) total teaching experience. The median number of years in present position of all teachers who reported in this aspect of the study is 3.84. The middle 50 per cent of teachers have served between 1.96 and 7.55 years. The median number of years of total teaching experience of teachers in cities is 10.19 years; villages, 5.94 years; supervisory districts, 4.05 years. The middle 50 per cent of the high-school teachers in cities have taught between 3 and 17 years; in villages between 3 and 11 years; in supervisory districts between 2 and 9 years.

The data for the number of subjects taught show that in New York City 90 per cent of the teachers teach only one subject. In other cities of the state more than 80 per cent teach one subject, 14.1 per cent two subjects, 1.8 per cent three subjects, and 0.2 per cent four subjects. In villages 75 per cent teach one subject, 19 per cent two subjects, and 5 per cent three subjects. In supervisory districts 38.8 per cent teach one subject, 37.2 per cent two subjects, 17.2 per cent three subjects, 5.1 per cent four subjects, and a few more than four subjects.

The study also gives data regarding subject combinations of teachers who teach three or more subjects, the extent to which each subject is taught as a first or only subject, the extent of first-subject combinations, the variety of teaching certificates held, the nationality of high-school teachers, the occupations of fathers. Under the heading of salaries the report indicates that the average salary for high-school teachers varies as to size of community. Villages have a median salary approximately $300 higher than supervisory districts, while cities have a median salary that is much higher than villages.—*School & Society.*

WORLD FEDERATION OF EDUCATION ASSOCIATIONS

Presidents of three great national educational organizations will appear together on one general program of the World Federation of Education Associations which meets in Denver, July 27 to August 1. They are: ANGUS ROBERTS, M. C., London, president of the National Union of Teachers of England and Wales; COUNT HIROTARO HAYASHI, Tokyo, Japan, president of the Imperial Japanese Education Association; and DR. WILLIS A. SUTTON, Atlanta, Georgia, president of the National Education Association of the United States.

A general attendance of four thousand persons representing fifty or more countries of the world is expected.

The American Child Health Association will hold its annual convention in conjunction with the Health Section of the World Federation.

Educational exhibits from various school systems of the United States and numerous foreign countries will be on display in the new and beautiful West High School of Denver.

The list of distinguished guest speakers includes, in addition to the three presidents of national education associations, DR. EDWARD ELLSWORTH ROSS, of the University of Wisconsin, noted sociologist and author; HONORABLE WILLIAM GREEN, president of the American Federation of Labor; P. SESHADRI, Cawnpore, India, prominent in educational fields of India; LOFTUS H. REID, trustee, City Schools, Toronto, Canada; PROFESSOR H. RADLINSKA, editor of the *Annuaire Pedagogique*, Warsaw, Poland; FRANK GOLDSTONE, general secretary of the National Union of Teachers of England and Wales; DR. PING WONG KUO, Shanghai, China, former president of the University of Nanking; DR. HARRY CHARLESWORTH, Vancouver, Canada, general secretary of the British Columbia Teachers Association; PROFESSOR DON PABLO MARTINEZ DEL RIO, Mexico.

Members of the local executive committee in charge of arrangements for the convention are: A. L. THRELKELD, superintendent of schools, Denver, chairman; FREDERICK M. HUNTER, chancellor of the University of Denver; W. B. MOONEY, executive secretary, Colorado Education Association; INEZ JOHNSON LEWIS, state superintendent of public instruction; and MARY C. C. BRADFORD, former state superintendent of public instruction.

THE FINAL MEETING OF THE CHEMISTRY TEACHERS' CLUB OF NEW YORK

The Chemistry Teachers' Club of New York held its final meeting of the academic year Friday evening, May 22, as guests of the Chemistry Department of the College of the City of New York. Sixty-one members were present at the dinner.

The brief business meeting which followed included reports from retiring officers and committees and the election of officers for 1931–32. A surprise feature was provided by PROFESSOR L. C. JORDY of Brothers College, in the character of Professor Phineas T. Vacuum, D.Ph., of the University of Pinaud, who presented his famous experimental lecture on "Watah."

The meeting then adjourned to Doremus Hall to hear a most interesting travelog by PROFESSOR H. R. MOODY, Chairman of the Department. Dressed in Arab costume, Professor Moody described his recent trip through Northern Africa, while exhibiting a series of lantern slides and several reels of moving pictures.

The report of the retiring chairman, J. M. CEGLOWSKI, included the following résumé of the year's activities:

Nov. 1—Joint meeting with the Physics Club at the Stuyvesant High School. Discussion on the proposed Revision of First Assistants examinations led by MESSRS. WHITSIT and BROWNLEE. DR. J. H. BECKER, Bell Telephone Research Laboratories, discussed atomic structure and wave mechanics.

Nov. 22—Excursion to the National Lead Company's Research Laboratory in Brooklyn.

Dec. 30—Meeting at Cooper Union. DR. EGLOFF, Universal Oil Products Company, Chief of Staff; lecture on "Cracking Process in Gasoline and Gas Production."

Jan. 10—Meeting at the Washington-Irving High School. Subject: "Are Professors Human?" Representatives from City College, New York University, Cooper Union, Pratt Institute, Manhattan College, Stevens Institute, Fordham University, and Drew University were present to show that they were. A surprise "sandwich, coffee, ice cream, and cake" party after the meeting aided in making this meeting one of the most successful ever held by the Chemistry Teachers' Club.

Feb. 14—Meeting at George Washington High School. PROF. HURD of Teachers' College led a discussion on practical teaching problems and demonstrations, including equations, superior pupil, chemistry work book and crystal growth.

Mar. 21—Science Luncheon at the Hotel New Yorker. Addresses by DR. HARRISON E. HOWE, Editor of *Industrial and Engineering Chemistry*, and DR. WM. SEIFRIZ, of the University of Pennsylvania Botanical Laboratories.

Apr. 18—Spring Excursion to the Four Plating Company and the Hanovia Manufacturing Company of Newark, N. J.

May 22—Final meeting.

The report of the retiring chairman, H. A. WHITNEY, included an inspiring challenge to the club membership. He

urged that every objective of the club should be a definite contribution to chemical education. He recommended in particular: (1) That the club become a local clearing house, in the operation of which a small monthly bulletin might be published to contain data, suggestions, criticisms, offers of assistance and participation by members. (2) That records of surveys, etc., be classified and retained in permanent form. (3) That the constitution, roll of members, and standing committees be published. (4) That a greater number of members be enlisted in active work by (*a*) increasing the number of important committees, giving some of the men more recently admitted to membership recognition; (*b*) placing a higher premium on membership in the club by more strict attention to credentials for membership; (*c*) impressing high-school chairmen that every department should have representation at club meetings and that club activities should receive attention in department conferences; (*d*) renewing our efforts to secure credit for alertness courses; for members who are doing special club work and eventually for regular attendance on club functions. (5) That committees be organized on (*a*) programs, (*b*) mass education, (*c*) chemical museums, and (*d*) visual instruction. (6) That closer contacts be established between our own groups and other organizations such as (*a*) The American Institute of Chemists, (*b*) The Division of Chemical Education of the A. C. S., (*c*) Exposition of Chemical Industries, (*d*) other associations of science teachers. (7) Enlargement of records of individual members to include permanent card index making available date of admission to membership, past contributions and special interests, to enable officers and committees of club to select those best fitted to undertake various projects. Mr. Whitney concluded by saying, "This insistence on the importance of a continuous working plan is due to the fact that I am personally appalled by the worship of mass production to which our country has dedicated itself. It is absolutely necessary that every person charged with the direction of education, face the evils as well as the blessings of that mass production, announce their findings, support large-scale production where it is of real value, but oppose its extension into fields where it threatens realization of the highest ideals of civilization; but, above all, as long as this mass education is now upon us, begin an immediate study to determine how our instruction in chemistry may be adapted to meet the practical needs of the young people who are being herded into million-dollar mental catacombs."

The following officers were elected for 1931-32:

President, EARL M. WASHBURN, Brooklyn Technical High School; *Vice President*, JOHN M. CEGLOWSKI, De Witt Clinton High School, Bronx, N. Y.; *Secretary*, EVANS C. BRUNNER, Great Neck High School, Great Neck, L. I.; *Secretary*, R. A. BAKER, College of the City of New York.

CONFERENCE FOR INVESTIGATORS INTERESTED IN THE CHEMISTRY AND PHYSIOLOGY OF PLANTS

New Haven, Connecticut, June 5 and 6, 1931

Program

Friday, June 5, 2:00 P.M.

Connecticut Agricultural Experiment Station.

Welcome—DIRECTOR WM. L. SLATE.

Inspection of the experimental work of the various departments of the Connecticut Agricultural Experiment Station.

U. S. Office of Forest Pathology—DR. RUSH P. MARSHALL.

Marsh Botanical Garden—PROF. GEO. E. NICHOLS, MR. J. H. MURRAY.

Osborn Botanical Laboratory—PROF. HEMPSTEAD CASTLE.

Faculty Club, Dinner—6:30 P.M.

Sage Hall Club Room, 8:00 P.M.—DR. GEO. P. CLINTON, *Chairman.*

Welcome to Yale University—PROFESSOR ANDREW KEOGH, Yale University Librarian.

Plant Sciences in the Sheffield Scientific School—DIRECTOR RUSSELL H. CHITTENDEN, Professor Physiological Chemistry, *Emeritus*.

Plant Science Research in the Yale School of Forestry—PROFESSOR JAMES W. TOUMEY.

The Need for Coöperation in Biochemical Research—PROFESSOR TREAT B. JOHNSON.

Saturday, June 6, 9:00 A.M.

Osborn Botanical Laboratory, Room 360.

Presentation of Research Papers.

CONFERENCE OF INTERNATIONAL STUDENT SERVICE

DR. WALTER KOTSCHNIG, general secretary of "International Student Service," with headquarters in Geneva, recently arrived in the United States to coöperate with the American committees of the organization in perfecting plans and program for the tenth annual conference which will be held at Mt. Holyoke College, September 1 to 10.

The stated program of the service is as follows: (1) the study of, and research on, university questions; publications thereon; (2) the development within the universities of friendly relations between students and professors of different nationalities and races, and of their contacts with other social classes, by the organization of lectures, conferences, study, travel, etc.; (3) the development of student self-help and creation of student coöperative enterprises; (4) material help and moral aid for students.

Increasing emphasis is being laid by those directing the movement to the fact that the title "International Student Service" has become somewhat of a misnomer, and that the original program which consisted largely in the administration of relief to needy students in Central Europe, has gradually evolved into a university movement for international understanding, in which educators, public men, and students in some thirty countries take an active interest. It is toward a real intellectual coöperation between the students and universities of the world that the organization now directs its activities primarily, although still vitally interested in securing emergency aid for needy students wherever their need may be most apparent.

Since 1920 more than two and one-half million dollars have been raised for the latter purpose. The result of the relief movement was not solely evident in an improved material condition of those in distress, but likewise in the development of a constantly happier and more sympathetic understanding between the national student groups. Through cooperation in alleviating distress they came to know each other, and to understand each other's ideals, which in most instances were found to be identical.

International Student Service has in recent years directed successful "seminars in international understanding" through a Conference of Students from the Pacific Countries enrolled in European universities, an Indo-European Conference, and a Conference of Jews and anti-Semites. A Chinese-European Conference, a Balkan Conference, a Conference of North and South American university people, and a meeting of French and German students are to be held in the near future. The last annual conference was held in October, 1930, at Oxford. The meeting of this year at Mt. Holyoke is the first to be held in the United States.—*Science*

NEW BULLETINS ON OPERATION OF COLLEGES AND UNIVERSITIES

The Office of Education's Survey of Land-Grant Colleges (*Bulletin* 1930, No. 9) which was originally published in two large volumes ($1.50 each) is now available in twenty-one parts from the Superintendent of Documents, Govern-

ment Printing Office, Washington, D. C. Prices range from 10¢ to 30¢ for each part.

While the survey report refers only to the sixty-nine land-grant colleges, the information is invaluable to the faculties and students of all colleges and universities in the United States.

The separate sections deal with the following phases of land-grant college education:

Volume I

I	Historical Introduction—10¢
II	Control and Administrative Organization—10¢
III	Business Management and Finance—30¢
IV	Work of the Registrar—15¢
V	Alumni and Former Students—10¢
VI	Student Relations and Welfare—25¢
VII	Staff—10¢
VIII	The Library—15¢
IX	Agriculture—15¢
X	Engineering—10¢
XI	Home Economics—25¢

Volume II

I	Arts and Sciences—10¢
II	Commerce and Business—15¢
III	Teacher Training—30¢
IV	Military Education—10¢
V	Professional Veterinary Medicine—15¢
VI	Summer Session—10¢
VII	Extension Service—25¢
VIII	Research—25¢
IX	Graduate Work—20¢
X	Negro Land-Grant Colleges—15¢

It was deemed advisable to publish the survey findings in parts so that certain definite information might be made available at a nominal sum. However, the complete survey report may still be purchased.

NEW LAWS FOR AMERICA'S SCHOOLS

A review of educational legislation enacted in the forty-eight States during the past two years reveals that major educational problems in the United States are school finance, teacher certification and pensions, school attendance, curriculum changes, state and county administration, school consolidation, pupil transportation, and education of physically and mentally handicapped children, according to the Office of Education, U. S. Department of the Interior.

Curriculum changes under recent state laws range from the prohibition of the teaching of the evolution theory in Arkansas public schools and colleges, to provision for the teaching of aviation in Tennessee schools. Numerous states now require a study of the U. S. Constitution. Texas requires a course in national and state constitutions in high schools, teachers' colleges and universities, and a study of the American flag is now compulsory in Tennessee public schools. Other subjects authorized to be taught are vocational guidance, public safety, character and physical education, and religious instruction.

The study of educational legislation in the United States has been made by DR. WARD W. KEESECKER, Office of Education school legislation specialist, and appears as an advance chapter of the Biennial Survey of Education in the United States, 1928–30.

School finance held the attention of state legislators in 1929 and 1930 more than any other school problem. The principle that school facilities and school costs should be equalized as far as practicable throughout the state won legislative sanction in approximately one-half of the states.

Recent legislation has changed the composition and function of a few state boards of education, fixing more responsibility for public school administration upon state school officials. Recent years have also witnessed legislation authorizing counties to vote whether their school districts shall be merged into county-wide systems. It is observed, however, that progress toward the county centrali-

zation has been slow in states where permissive laws prevail. Alabama, Florida, Kentucky, Louisiana, Maryland, New Mexico, North Carolina, Tennessee, Virginia, and Utah now have fairly well-developed county unit plans. The county unit plan is partially developed in Arkansas, California, Georgia, Minnesota, Mississippi, Montana, Ohio, Oregon, South Carolina, and Texas.

Laws increasing qualifications of county superintendents were enacted in Montana, North Carolina and Wisconsin during the biennium and legislators in Minnesota, Missouri, Montana, North Carolina, Texas, and Pennsylvania voted to increase salaries of county superintendents in their respective states. Mississippi provided for county superintendent assistants and also authorized employment of county primary work supervisors. Furthermore, by authorizing the consolidation of two or more adjacent districts, legislatures are gradually vesting local control of schools in larger administrative units.

Twenty-five states gave legislative attention to teachers' pensions in 1929 and 1930, the review discloses, endeavoring, in the main, to improve retirement systems already established. State commissions to study teachers' retirement problems were appointed in Delaware, North Dakota, and Michigan. Extension of teacher retirement so as to include other school employees was made legal in California, Colorado, New Jersey, and West Virginia. Vermont increased the minimum retirement allowance to $200 per annum, and retirement for teachers in districts annexed to cities having retirement systems was granted in Wisconsin.

State-wide teacher pension systems now operate in Arizona, California, Connecticut, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nevada, New Jersey, New York, North Dakota, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, the District of Columbia, Alaska, Hawaii, and Porto Rico. Approximately one-third of the forty-eight states have pension systems applicable only to certain cities or districts.

Legislation to promote increased school attendance has been enacted in a number of states since 1928, providing for longer terms, additional qualifications for labor permits, lower compulsory school attendance ages, transportation of pupils, and free tuition. Alaska passed a law requiring school attendance at seven years of age instead of eight. Oregon now requires attendance at eight years instead of nine. The annual school term in Main has been extended from thirty weeks to thirty-two weeks and Missouri requires completion of the sixth grade for employment during school hours. Children must now complete elementary school for labor permits in Maryland, instead of the fifth grade. A commission to study the problem of increasing school attendance, especially of employed minors, was authorized in Massachusetts' legislation.

Arkansas, California, Colorado, Idaho, Iowa, Kansas, Kentucky, Minnesota, New Jersey, New York, North Dakota, Oregon, South Carolina, Texas, and Wisconsin enacted legislation during the past two years to promote school attendance by providing for free tuition in other school districts or transportation of pupils.

The practice of legislatures to provide for educational surveys before enacting legislation pertaining to schools continued unabated during the biennium.

ALL COLLEGE SOPHOMORES MAY BE GIVEN UNIFORM EXAMINATION

About a quarter of a million sophomores in colleges, teachers' colleges, and junior colleges will be examined simultaneously on two days in May of 1932, if success meets plans of the Coöperative Test Service as outlined at the meeting in Washington, D. C., of the American Council on Education by DEAN J. B. JOHNSTON, of the University of Minnesota,

and DIRECTOR BEN D. WOOD of the *Service*.

Every college is invited to take part in this coöperative testing program, and other classes may take the same tests if the college desires it.

The same examination will be given throughout the whole country, so that any individual student may learn how he compares with all others, not alone in his own state but from Maine to California.

Included in the examination are tests of intelligence, general culture, general science, and English. Six and a half hours will be required for the examination, which will be given in two periods.

The examination and others for use in future years will be constructed, tried out, and standardized by the Coöperative Test Service. It will be of the objective type which may be scored with the use of a definite key of correct answers.

"Objective examinations are difficult to construct properly and are open to serious objections when not handled with sufficient care and intelligence," Dean Johnston told the college presidents and other educators at the meeting. "They are likely to be merely fact-finding and may fail to seek out the power of the student to think or to utilize what he has learned. Indeed, the individual questions may be so faulty in form that their meaning is not clear and they therefore fail to measure even the factual knowledge which the student possesses. However, these are not necessary limitations and in the hands of experienced, ingenious, and painstaking persons objective tests can be made to measure not only the memory of factual knowledge but also the power of reasoning about the facts or of making use of the facts in solving problems or in constructive work. Even when they measure primarily information they furnish important data, since effective thinking is partly dependent upon the facts which are at the ready command of the thinker. Teachers and administrators will realize clearly that no single test can tell the whole story concerning an individual, and should exercise judicious care in using all available sources of information, including subjective examinations and personal judgment. That much useful data can be furnished by objective tests has already been demonstrated by the experience of many high schools and colleges. No claim is made that they are an adequate measure of all the outcomes of good instruction."—*Science Service*

THE THIRTEENTH CHEMICAL EXPOSITION*

Any misgivings which may have been entertained that general business conditions might seriously interfere with the success of the Thirteenth Exposition of Chemical Industries were dispelled by the presence of some 500 visitors who crowded in front of the building waiting for the doors to open on Monday, May 4. The exposition, held at the Grand Central Palace in New York from May 4 to 9, 1931, was unusually successful. Not only were there many thousands of visitors, but there was business transacted and the exhibitors expressed considerable satisfaction over the interest shown. The crowds made intelligent inquiries and observations. There were fewer of those who seemed merely bent on satisfying their curiosity. Those who came took the time really to inform themselves. There was a large sprinkling of bankers and those interested in investment and other financial organizations. The educational features were in no wise neglected, as is shown by the success of the student courses, and the large audiences which attended the symposium on "Plastics" held two successive afternoons and the meeting under the auspices of the Society

* For previous items regarding the Thirteenth Chemical Exposition which have appeared in the JOURNAL OF CHEMICAL EDUCATION, see **8**, 398–9 (Feb., 1931); **8**, 769–70 (Apr., 1931); **8**, 919–28, 1001–4 (May, 1931).

Ind. Eng. Chem., News Ed.

BOOTH OF THE AMERICAN CHEMICAL SOCIETY

of Chemical Industry which devoted its program to solvents.

Among the 360 exhibitors were both old friends and newcomers. References to these displays will be found in a section devoted to the exposition in the May 1, 1931, issue of *Industrial and Engineering Chemistry*. Considered by subjects, the wide use of synthetic plastics stood out as one of the prominent developments marked by the exposition. For some time synthetic plastics have been prominent in these expositions, but there were more of them shown for more diverse uses than heretofore. We have become familiar with these materials in our fountain pens and pencils, cars and golf clubs, automobiles, and radios. They now enter upon new lines of service for the construction of acid- and alkali-resisting equipment, pumps and pipes, valves and tanks, pipe fittings, and as resins to compete with varnishes, yielding results claimed to be superior in many ways. Another impressive class of materials was the alloys and the new metals. Of course, Duriron, monel, and Allegheny metals were shown, but in addition nickel-clad steel, offering a high degree of protection at attractive prices, a new alloy high in chromium prepared by smelting the chromium with the iron, thereby imparting new characteristics, and tantalum now offered for use in plant equipment, magnesium alloys for construction, Dow metal, rhodium electroplated for corrosion resistance, metallic columbium, and gallium accompanied by the newly discovered element rhenium, shown in metallic form for the first time, were also displayed. The influence on ceramics of the appearance of these new alloys was manifested by the presence of improved ceramic ware in new form and equipment, still offering its own advantages for special uses.

Cellulose acetate, in various forms from the dry material to sheets offering close approach to flexible glass, was to be found, one form not subject to discoloration by exposure to light. Rubber also impressed

itself upon the exposition, for there were interesting fittings and equipment of hard rubber, examples of commercially electrodeposited rubber, rubber-lined pipe, rubber sheet with special characteristics to resist chemical action and abrasion, and emulsified compounds to be brushed or otherwise spread on wood or metal for protection. Improvements in the older forms of rubber linings were displayed, and the newest wonder in the field, synthetic rubber prepared from petroleum, was on display, notwithstanding reports to the effect that Mr. Edison has said it could not be done.

While it is impossible even to list all the interesting and important developments shown, we will mention a few that impressed the visitors. One booth displayed several phase rule studies illustrated by space models in four dimensions constructed of cellulose plastic sheets. Tantalum carbide, an unusually hard material, was displayed and recommended for tipping lathed tools. Furfural, always interesting, was offered in solutions for killing dandelions and other weeds which are the despair of those who attempt respectable lawns. There was a down-feed filter of small size but with what seemed an enormous capacity for its dimensions—some 20 tons of granular material per day. Gluconic acid, a derivative of glucose, was present with a whole series of compounds based upon it. Its lactone has been seriously suggested for use in baking powders, and there were a number of its metallic salts, all of which are now commercially available. Photoelectric cells attracted a great deal of attention. Their application was shown in a variety of ways from sorting colored balls to acting as burglar alarms. Chemists found in the booth of J. Bishop Platinum Works a certificate which had been awarded that company at the Centennial Exposition in Philadelphia in 1876. This certificate bore, among others, the signatures of J. Lawrence Smith and F. A. Genth, charter members and early Presidents of the American Chemical Society. Complete sets of reagents for student use, packed individually in amounts intended to serve for predetermined courses of study, were offered to reduce the trials and tribulations of stock rooms in schools. New solvents, colloidal sulfur, American-produced iodine, new testing devices, a Sargent gas calorimeter, the first to be made in the United States, a device for testing the tenderness of fruits and vegetables, and displays calling attention to certain natural resources along railway systems and in the Dominion of Canada indicate the breadth of the exposition.

The American Chemical Society displayed enlargements of pages from *Industrial and Engineering Chemistry*, where certain information had been published for the first time. These were chosen from some of the material which had appeared since the last exposition. The materials concerned were displayed on tables. Above these pages were placed portraits of the Society's board of fourteen Directors, and many who did not know the gentlemen personally commented upon the capable appearance of the group. The exhibits comprised the following materials:

Fermentation of cellulose to lactic and acetic acids, as developed at the University of Wisconsin.

Cellulose acetate silk from the plant of the Tennessee Eastman Co.

Anhydrous aluminum chloride, as produced commercially by the Gulf Refining Co.

Metallic columbium in wire, sheet, and bar form from the Fansteel Products Co.

Alloys of barium and strontium with tin, lead, and silver made by K. H. Ray, University of Iowa.

Metallic magnesium, as commercially used, from the Dow Chemical Co.

Products of the hydrogenation of petroleum from the Standard Oil Development Corp.

Phenol resinoids, as used in fast-drying, resistant varnishes, supplied by the Bakelite Corp.

Dichloro-difluoro-methane, a non-toxic, non-inflammable material for use in refrigerating machines, as developed by Thomas Midglev, Jr.

Rubber synthesized from petroleum by B. T. Brooks.

Triethanolamine, important as a mild organic base and emulsifying agent, and ethylene oxide, effective as a fumigant, by Carbide and Carbon Chemicals Corp.

Photoelectric protection, designed to warn, by flashing a light, of any attempt at theft of exhibit material, was supplied in the Society's booth by the General Electric Co., much to the amusement of children, both young and old.—*News Ed., Ind. Eng. Chem.*

STUDENTS' COURSE AT CHEMICAL EXPOSITION HIGHLY SUCCESSFUL

The Fifth Students' Course of the Exposition of Chemical Industries far exceeded any previous course, both in interest and in attendance. In fact, the number of students who attended the various lectures was approximately as great as the sum of all who attended the four courses of former expositions. It is rather difficult to compare attendance of this course with those which preceded it, since there were three successive courses of two days each, rather than a single course of one week's duration. Some students took two courses, a few all three, and others attended for only a single day. Each student who entered the exposition doors was asked to make out an information card, and practically all did. The data thus secured have been tabulated, and the cards will be filed for future use.

There were three ways in which the exposition was used by students. A great number, mainly from the New York district, and of varying degrees of preparation and interest, came for a few hours and for the most part without guidance, without credit, and without direct relation to class work. Some such students got something worthwhile out of the show; others got very little; and a few constituted a liability. The second class included students who attended no lectures, but who studied the exhibits in charge of instructors as a part of a regular inspection trip. The University of Pennsylvania seniors in chemical engineering, nineteen in number, spent one afternoon at the exposition. Ohio State University was represented by a group of fifty-eight students, who spent three days in the New York district visiting plants during the day and putting in three evenings of three hours each at the exposition. Lehigh University was represented one day by approximately thirty students. The third group was composed of a very considerable number of college classes, in charge of instructors, who attended lectures in the mornings and studied what the exposition had to offer in the afternoons and evenings. Most of these classes were at the exposition for only one course of two days, but some stayed longer. New York University, for example, sent its juniors and seniors in chemical engineering to the first two courses, divided the remainder of the time of these students between the exposition and plant trips, and sent about one hundred evening-course mechanical engineers for one three-hour period in charge of instructors as a part of their class work. Cooper Union students were in the midst of examinations but a good number attended.

It is obviously a necessary policy to refuse admission to all high-school students unless they are in very small groups and in charge of responsible teachers. A limited number of exceptional high-school students were admitted, the number, including teachers, being around two hundred.

In order to take care of those students not in regular classes, an instructor was provided, but relatively few availed themselves of this service.

There were twenty-nine lectures announced on the final program. [See J. CHEM. EDUC., **8**, 1001–4 (May, 1931).] The lecturers appeared as announced, and no lecturer had less than one hundred hearers. The classroom seated one hundred and fifty, and at times every seat was taken and some were forced to stand. The lectures were on a great variety of topics, were suited to the different types of students, and were uniformly of the high standard which has always characterized these courses. Four of the speakers were editors of chemical journals, two were directors of research institutes, nine were teachers of chemical engineering, and the remainder were connected with chemical industry in various capacities.

After the close of these courses at noon Saturday, there was a luncheon for teachers at the Hotel Lexington. This was attended by sixty-four. In the afternoon CHARLES H. HERTY made a most interesting address on "The Teaching Values of the

Exposition," illustrating his remarks by quotations from newspapers relative to events of recent occurrence. His theme was largely the romance of research as represented by its products in the exposition. At the close of Doctor Herty's talk several groups were formed in charge of chemical engineers who pointed out the high lights of the exposition.

As far as the records go, the following institutions were represented by classes in charge of instructors, the approximate number of students being given:

Institution	*Students*
Brooklyn Polytechnic Institute	26
New Jersey State Normal School	32
New York University	19
Pratt Institute	36
Princeton University	17
Brown University	11
Rutgers University	47
Drexel Institute	11
Stevens Institute of Technology	12
Syracuse University	11
Trinity College	8
University of Delaware	15
Wesleyan University	28
Yale University	27
Ohio State University	58
University of Pennsylvania	19
Lehigh University	27

Information cards indicate that a number of other institutions required of their students a certain amount of work at the exposition, but the extent of these requirements has not yet been found out.

About forty individuals from industries attended different lectures.

In addition to the above-mentioned institutions, the following were represented by students at the exposition:

Adelphi College
Albany College of Pharmacy
Barnard College
Bates College
Carnegie Institute of Technology
College of the City of New York
Columbia University
Cooper Union
Drew University
Fordham University
Hunter College
Lafayette College
Long Island University
Manhattan College
Massachusetts Institute of Technology
Newark College of Engineering
New Jersey College for Women
Philadelphia College of Pharmacy
St. John's College
St. Francis' College
St. Peter's College
Tri-State College
Trinity College
Union College
Upsala College
Vassar College
University of Virginia
Wagner College

Total number of individuals registered for lectures..... 552
Total number of information cards made out by students..... 2347
—*News Ed., Ind. Eng. Chem.*

EMBLEM OF CHEMICAL ABSTRACTS

Interest has been expressed in the symbolism of the "spot"—the emblem which is printed regularly on the covers of *Chemical Abstracts* and which is reproduced herewith.

Ind. Eng. Chem.

When the present cover for *Chemical Abstracts* was designed two years ago, EDITOR CRANE was fortunate, as he explains, in having the help of THOMAS E. FRENCH, a man of wide reputation in lettering and design. He advised a decorative spot for the middle of the page. It was decided to try to work out a distinctive emblem which would combine attractive appearance and appropriate symbolism.

Accordingly Professor French was asked to design an emblem which might be considered to symbolize the boiling down to abstract form of the chemical literature appearing throughout the world. How well he succeeded, each can judge for himself. The globe and the books are meant to symbolize world literature. The evaporating dish on the tripod, with fumes passing off, suggests that chemical literature is meant and symbolizes the boiling-down process. The C. A. mono-

gram is added for balance and to identify the whole as distinctly a *Chemical Abstracts* emblem.—*News Ed., Ind. Eng. Chem.*

LAST MISSING CHEMICAL ELEMENT DETECTED BY NEW METHOD OF ANALYSIS

The one remaining unknown chemical element, number 85, has been detected for a first time in sea water, potassium bromide, common headache drug, and in a number of well-known minerals by a method of super-chemical analysis so delicate that it can recognize one part in a hundred billion of water.

The discovery is announced by DR. FRED ALLISON, EDGAR J. MURPHY, PROF. EDNA R. BISHOP, and ANNA L. SOMMER working at the Alabama Polytechnic Institute in Auburn, Alabama. Two of these, Dr. Allison and Mr. Murphy, are the same scientists who a year ago discovered the next to the last unknown element, number 87, next door neighbor to radium in the chemist's table of the ultimate building blocks of matter. Ninety-two elements now form the completed list. The new element, 85th when the elements are arranged in the order of the number of their extra-nuclear electrons, is a family relative of iodine, long popular as an antiseptic. It has not yet been separated, for only one part in a billion is present in the substances examined.

However, in their letter to the *Physical Review*, in which the announcement is made, the discoverers say that concentration of a purer form of the element from monazite sand is being attempted and is making good progress. The "eka-iodine," as Mendeléeff would have called it in his original periodic table, is being separated as the "85-ite" of lithium. Monazite sand is well known as the source of the cerium and thorium used for the mantles of Welsbach gas burners.

Other materials in which number 85 has been found are: kainite, a potassium magnesium sulfate found in the famous German Stassfurt salt deposits; apatite, which is a fluoride and phosphate of calcium and barium; and fluorite, or calcium fluoride; as well as in the laboratory reagents hydrofluoric and hydrobromic acids.

An unexpected fact is noted in that the acid formed from the new element, "85-ic" acid, does not show itself when nitric and hydrochloric acids, bromine, and iodine are added to the solution, but reappears when so-called reducing agents such as the dioxide of sulfur are present.

The new method of analysis depends on a strange phenomenon discovered a long time ago by Michael Faraday, one of the greatest scientists of all time. The Faraday effect has to do with what happens to a beam of light passing through a transparent substance placed between the north and south poles of a powerful magnet. The vibrations of the light beam, if polarized, are found to have rotated on passing through the magnetized liquid.

About a billionth of a second elapses after switching on the magnet before the influence on the light vibrations is observed in the liquid. This lag is found by Dr. Allison and his associates to be different for different substances. It is this delay that gives a means of identifying extremely small amounts of substances and in particular the first traces of the new chemical element 85. Because of its small amount the lag was not discovered until a year or two ago when Dr. Allison invented his new method of measuring it.

No satisfactory explanation of the phenomenon can be given on present theories, a fact which adds still further to the scientific interest of the work.

America seems to be making up for lost time in discovering the missing members of the chemical family. Until the discovery of illinium by PROF. B. S. HOPKINS at the University of Illinois in 1926 no element had first shown itself to an American investigator. Illinium's discovery left only two more elements

to be discovered in order to complete the chemical periodic table, that great generalization achieved by the Russian chemist Mendeléeff in the 1870's.

If the discovery of element 85 is confirmed by other investigators, the United States will have the distinction of having found the three last and therefore the most inaccessible of all the elements.

Six elements have been discovered in the last seven years. Number 72, called hafnium after the city of Copenhagen, (Danish, *Köbenhavn*) was discovered in 1923 by PROF. D. COSTER and DR. GEORG HEVESY. Numbers 43 and 75 were isolated in 1925 and 1926 at the University of Berlin by DR. WALTER NODDACK and his collaborators and named masurium and rhenium.

Very few experiments have been made to find the new number 85.

Many attempts on the other hand had been made to find number 87, which must be very similar to the common elements sodium and potassium but all reports of success in this search, before Prof. Allison's, have been disproved by subsequent experiments. It has been thought that as radium is number 88 in the list that the recently missing 87 might give off the same radioactive rays as radium. For a similar reason we may expect the newly arrived number 85 to be also active like radium. All the heavy elements at the bottom of the table continually disintegrate in this way.

Actually all potassium compounds show radioactivity to a slight extent but careful research by Hevesy and others has shown that the rays of potassium cannot possibly be due to a trace of the long-sought element 87.

Chemists and physicists throughout the world will await with eagerness the opinion of further experimenters confirming or denying the claims of the southern group.—*Science Service*

SCIENCE PENETRATES STRUCTURES OF WOOD AND RUBBER

Rubber and cellulose are no longer the mysteries they once were, as a result of the work of PROF. KURT H. MEYER and DR. H. MARK of the I. G. Farbenindustrie A.-G.

By correlating the evidence from X-ray and chemical investigations with those of microscopic form it is now possible to have a clear idea of the arrangement of the atoms in the peculiarly complex structures of the natural substances constituting this paper or your tires.

It is easy to understand how a simpler substance like sugar, for instance, is built up, as there the molecular units are laid regularly side by side like the bricks in a wall. The molecules of cellulose, the tough, fibrous material of wood, cotton, linen, and paper or the carbon and hydrogen atoms of rubber, however, are linked together in a network resembling a sponge where it is difficult to say where one brick leaves off and the next begins.

The chemists have investigated these substances by breaking them into simpler fragments which they can identify, the physicists by passing X-rays through the intact sponge. Naturally they came to differing conclusions. By using these methods together with other lines of attack the I. G. laboratory has now cleared up this perplexing problem.—*Science Service*

CHEMICALS SEND YEAST TO SLEEP

New facts on the chemical control of the life processes of the yeast cell were reported recently to the Royal Society of Canada by DR. HELEN STANTIAL and DR. W. LASH MILLER of the chemistry department of the University of Toronto. They have found that acetate of soda and certain sugars will send yeast into a spore or sleeping stage.

It was Dr. Miller who two years ago surprised biological investigators by announcing at a meeting of the Royal Society the chemical formula for a substance, similar to but not identical with the vitamins, which is necessary for the growth of yeast.

Dr. Miller chose yeast cells because each microscopic yeast plant is composed of only one cell. This simplifies the investi-

gation. Yeast cells, less than a thousandth of an inch in diameter, can be brought up in large families all alike, and they can be watched at work under the microscope. Their activity shows itself by certain chemical changes which can be found by analysis. In addition to being easy to work with as material for biological experiments, the yeast cell goes through the same changes as the cells of larger living things.

Dr. Stantial and Dr. Miller can now do some of the things by means of lifeless compounds for which elusive vitamins, extracts of glands, or blood serum preparations were thought necessary.

These chemists have discovered that yeast grown with grapefruit juice would readily form "spores," or go to sleep. This "spore"-forming behavior is sometimes resorted to by yeasts dried up or deprived of food material. Analysis of the grapefruit juice revealed the constituents which serve as a sleeping powder. They are now inquiring whether yeasts which have "spored" can remember processes they have been taught. This experiment is of interest in the science of heredity.

Inosite, an alcohol, the magic compound previously announced as one of the essentials for growth, may be the agent which makes the cells break in two. On a diet containing insufficient inosite, giant yeast cells, or clusters stuck together, can be produced.—*Science Service*

ATOMS DECLARED NOT DEPENDABLE

How science is losing faith in the law of cause and effect was explained in a recent address at the University of Wisconsin by PROF. P. W. BRIDGMAN of Harvard University.

New experimental facts in the last few years, Prof. Bridgman said, have made us less certain as to the thoroughgoing uniformity of nature or the predictability of future events. When we refine our measurements beyond a certain point we enter a new domain of small things not before accessible, full of the most capricious irregularities. The new domain is that in which the motions of single electrons or atoms are concerned.

"Let us imagine the simplest large-scale situation, a billiard ball rolling without friction or other interference on a table-top. Let us imagine the table-top marked with lines a foot apart," Prof. Bridgman continued. "Then we all know that if we observe the ball to be at the zero mark when the second hand of our watch points to zero, and to be at the one-foot mark when the second hand points to one second, when the second hand points to two seconds we shall find the ball at the two-foot mark. . . .

"But experiment shows that if we were dealing with an electron instead of a billiard ball the experiment would entirely fail. . . . At two seconds we might sometimes find it at seven feet and sometimes at five feet, . . . and indeed sometimes at two feet, like the billiard ball."

Prof. Bridgman went on to discuss if there could ever be any practical effects arising from such small-scale uncertainties. An example of this sort of thing is known to every physicist in an apparatus so constructed that the effect of the entrance of a single electron into the sensitive part of the apparatus is amplified with vacuum tubes so as to give a crack of sound in a loud speaker or start or stop a piece of machinery.

"We may," he continued, "romance about the future religion of a superstitious race by imagining in the inmost shrine of their temple a speck of radioactive salt in process of disintegration, and attached to this a train of vacuum tube amplifiers, which shall ever and anon flood the temple with light, or beat a tom-tom, or perhaps sacrifice a victim."

The disintegration of such an atom, Prof. Bridgman said, is the sort of thing that experiment and theory both show is essentially unpredictable.

"A rather good argument might be made for this sort of thing," he went on, "and it really appeals to the imagination

in many ways, for we have here the possibility of a spectacular projection into the realm of ordinary sense of the eternally inscrutable foundations of our physical world. . . .

"I gather the impression that at the present time a number of biologists are prepared to admit that not infrequently the adjustment of a single cell may be so delicate as to be thrown out of balance and a reaction started by the entrance of a single free electron or light corpuscle into the cell. In such cases the behavior of the cell must be admitted to be unpredictable."

The notion of cause is not so simple as it seems. Suppose that one had a heavy weight attached to a support by a string; then he will find that whenever he cuts the string the weight falls. This would lead to the assertion that the cause of the falling of the weight was the cutting of the string.

"For instance," Prof. Bridgman concluded, "if I could by some heroic means remove the earth, then we are all convinced that the weight would no longer fall when the string is cut, and so we could justify the contention that the true cause of the falling of the weight was not the cutting of the string but the presence of the earth."

Prof. Bridgman's address is reported in full in the technical journal *Science*.—*Science Service*

LIFELESS DROPS MAY ACT LIKE LIVING CELLS

Drops of lifeless solution, suspended in another solution equally lifeless, can act as though they had life in them. They will increase in size, then divide, and the "offspring" drops in their turn grow and divide again.

The possibility of this and other life-like behavior was demonstrated on mathematical grounds by DR. N. V. RASHEVSKY of the Westinghouse Research Laboratory, East Pittsburgh, Pa., before the American Physical Society meeting recently in Washington, D. C. Dr. Rashevsky has not carried out experiments to demonstrate his theory, but the principles he laid down may be the general explanation for such special cases of "artificial cells" as those shown by DR. GEORGE W. CRILE at the Cleveland meeting of the American Association for the Advancement of Science last winter.

The growth and division of the imaginary, artificial, lifeless cells were all accounted for by Dr. Rashevsky on the simplest of physical assumptions. That a cell may keep its shape intact through several changes was also explained without considering any of the complicated structure actually occurring in the living cell.

"One of the most fundamental phenomena of life, if not the most fundamental one," said Dr. Rashevsky, "is the multiplication of a cell through division. All the facts of growth and multiplication of more complicated and highly developed organisms reduce in the last analysis to the growth and division of single cells."

Instead of attempting to give a detailed theory of such complicated phenomena, Dr. Rashevsky decided to investigate first some intentionally over-simplified cases which are never found directly in nature. It is through the study of intentionally over-simplified arrangements that finally remarkable progress has been achieved in other exact sciences outside of biology.

"Let us for a moment forget about actual living cells," Dr. Rashevsky said, "and investigate mathematically whether it can happen, and, if so, how it can happen, that a small liquid drop will spontaneously divide into two parts.

"It is found that such spontaneous division cannot occur, if the drop is in a perfectly resting state and is not undergoing any changes.

"Consider the case that a drop, which is surrounded by another liquid, interacts chemically with this liquid, so that the amount of liquid which constitutes the drop increases, just as would be true

with a small organism. If the drop thus grows at the expense of certain substances, contained in the surrounding liquid, then under some very general conditions, the drop will divide into two on reaching a certain size. Each half will then again grow up and again divide and so on."

Generations of droplets showing an evolution to more and more complicated chemical constitution can thus be formed without the interference of the experimenter, Dr. Rashevsky's theory indicates. This happens when the intervals between the successive divisions are unequal.

If the drop is below a certain minimum size, it will not grow but dissolve away. Thus in no case can an imitation droplet cell be formed spontaneously. On the other hand the number of drops may increase continuously through the process of division and subsequent growth, as long as substances necessary for this growth are contained in the surrounding liquid. "Life" persists so long as "food" is available.—*Science Service*

STUDIES UPSET THEORIES OF IMMUNITY TO DISEASE

Studies which upset present theories of immunity or resistance to disease were reported by DR. ARNOLD R. RICH of The Johns Hopkins Medical School at the recent meeting in Syracuse, New York, of the National Tuberculosis Association. Dr. Rich's work may lead to a change in the present methods of treating certain infections.

Immunity may be acquired from vaccination with large doses of killed germs, or from small doses of living germs picked up in the natural course of life. It protects the body from disease in two ways: by checking the growth of disease germs so that they die; and by preventing their spread to the rest of the body from their original point of entry.

It is a well-known fact, Dr. Rich said, that when the human body acquires active immunity to a certain disease germ, its tissues ordinarily become hypersensitive to the protein of that particular germ or bacterium. The next time the body is infected with that germ, the tissues at the point of infection are locally damaged and killed by amounts of the bacterial protein which are harmless to the normal body. Disturbing constitutional symptoms and even death may occur when amounts of the protein which would be harmless to the normal body find their way into the blood stream of the hypersensitive one.

The theory which Dr. Rich's studies have controverted is that this hypersensitivity to the protein of the germ is a necessary and helpful accompaniment of the development of immunity.

Dr. Rich stated that this is not the case, and described the series of experiments on which he based his opinions. He also recommended that scientists develop improved methods of freeing the body from this hypersensitiveness in infections in which it acts to endanger the life of the patient.

The problem is particularly important in connection with tuberculosis, Dr. Rich pointed out. By far the greater part of the destruction of tissue which occurs in tuberculosis is directly a result of the hypersensitivity of the tissues to the protein of the tubercle bacillus. If this hypersensitivity is not necessary for the operation of immunity to tuberculosis, prevention of its damage by means of desensitization might be of great service to certain tuberculosis patients.

With DR. ALLAN CHESNEY and DR. T. B. TURNER, Dr. Rich carried out experiments which showed that acquired immunity could be established without the development of hypersensitivity.

Next he and DR. J. HOWARD BROWN injected the blood of hypersensitive immune animals into normal, non-immune ones. The normal animals could in this way be given immunity to the infection without being made hypersensitive, they found.

In the final experiment, Dr. Rich with DR. F. B. JENNINGS found that if the

hypersensitivity of immune animals was entirely abolished by suitable methods of desensitization, the animals lost none of their immunity, but were able to withstand millions of deadly doses of virulent germs.

Dr. Rich also described studies which showed how the spread of disease germs is really prevented in the immune body. Formerly it was thought that this was accomplished by the inflammation occurring as a result of the hypersensitivity. This was one reason why scientists considered hypersensitivity a necessary evil. Dr. Rich showed that such is not the case. Instead, the blood plasma and tissue fluids of the immune body act upon the germs, changing them in such a way that they stick not only to themselves but to the cells and fibers of the tissues they have invaded. In this way they are kept at the original place of infection and are not able to spread into the body.—*Science Service*

INCURABLE TROPICAL DISEASE YIELDING TO SCIENCE

A report indicating that a cure has probably been found for a hitherto incurable tropical disease known as *coastal erysipelas* has just been received at the department of tropical medicine, Harvard University Medical School, Boston, Mass. The report is from PROF. RICHARD P. STRONG of Harvard who has been in Guatemala for the past two months studying the disease which has the scientific name, *Onchocerca caecutiens*. His report states he has found that plasmoquine in dilutions up to one to ten thousand effectively destroys the worm causing the disease when the worm is in the larval state in the blood.

Plasmoquine is a synthetic preparation of a quinine derivative used in the treatment of malaria. The disease Prof. Strong has been studying is very prevalent in Central and South America. It has been known for many years but no cure had ever been found. Recently it has been given more attention by scientists. The worm causing it is transmitted by gnats. The disease causes swellings or nodules under the skin and also affects the eyes, causing blindness. Prof. Strong reported that substances such as antimony compounds, neosalvarsan, mercurochrome, and prepared sera are relatively ineffective as destroyers of the causative worm when compared with cinchona derivatives, of which the best known is quinine.—*Science Service*

INSANITY A MATTER OF COLLOID CHEMISTRY

The following article was written especially for *Science Service* by DR. WILDER D. BANCROFT, professor of chemistry, Cornell University.

A permanent change in the brain means abnormal thinking, which we call insanity. When we boil an egg, the white coagulates. When we dissolve rubber in benzene, the rubber is dispersed. No such extreme changes take place in the brain; but there are two types of insanity, in one of which the brain is more coagulated than usual and in the other of which it is more dispersed than usual.

If a person is suffering from the coagulation type of insanity, drugs which counteract coagulation will help the patient. This has been done successfully by administering bromides and could probably be done better by the use of thiocyanates. If a person is suffering from the dispersion type of insanity, alleviation will be obtained by giving a drug which will tend to coagulate the brain tissues.

In 1921 Berger gave cocaine to eleven patients suffering from catatonic stupor and found that the majority of them became active immediately after the first injections, though the improvement did not last more than an hour or two. In 1930 Lorenz anesthetized a similar patient with sodium amytal.

All anesthetizations involve coagulation, and the patient passed through a normal state on coming out from the

anesthetic and before relapsing into the catatonic stupor. This patient was in an aroused mental state for about four hours, after which she fell into a natural sleep for five hours. Later the symptoms of mutism, muscular rigidity, and active negatism developed slowly.

This spring DR. LANGSTRASS of St. Elizabeth's Hospital in Washington reported that he had administered carbon dioxide and oxygen in suitable proportions to a patient who had suffered from catatonic stupor for ten years. This, coupled with other treatment, has kept the patient in an apparently normal state for nearly two years, a remarkable medical triumph.

Of course treatments of this sort will not restore brain tissue which has been eaten away by syphilis or anything of that sort; but they will enable the physician to get the coagulated tissue back into a more nearly normal state.

Overdoses of a dispersing agent should give a normal person a dispersion type of insanity, while overdoses of a coagulating agent should give the coagulation-type of insanity. Naturally, there are not many data on this point because nobody wishes to make a sane person insane. When treating people for high-blood pressure, it has been found that continued administration of large doses of sodium thiocyanate gave rise to hallucinations of sight and hearing, mania, confusion, and ideas of persecution, singly or in combination. Since the patients recovered in a week after giving up the drug, these were cases of temporary insanity.

The exclusion of oxygen causes unconsciousness due to asphyxiation. When the oxygen is not cut down so much, interesting mental reactions occur. Aviators may become incapacitated temporarily when flying at high altitudes. There is a height for each aviator above which it is not safe for him to go, as he may develop mental confusion, leading to errors of performance; sometimes hallucinations of sight and hearing; and, in some cases, an uncontrollable desire to sing and whistle. This last is rather an anticlimax.—*Science Service*

ATOMS COMBINE IN SUN'S ATMOSPHERE

Not all chemical compounds break up in the intense heat of the sun's atmosphere, PROF. HENRY NORRIS RUSSELL of Princeton University recently told the meeting of the National Academy of Sciences in Washington, D. C.

It was formerly supposed that no chemical molecules could form in the sun. Fourteen different compounds have now been discovered there, six in the photosphere or outer layer and eight more above the darker sunspots.

Hydrogen and oxygen occur most frequently in these compounds, hydrogen being the most abundant constituent of star atmospheres. As the behavior of the substances is well known on the earth the extent of their dissociation in the sun and stars can be calculated with some accuracy. The results are in good agreement with observation.—*Science Service*

CARBON MONOXIDE MADE NON-POISONOUS BY FAMOUS GERMAN CHEMIST

Carbon monoxide, the ingredient in ordinary household gas that makes it poisonous, can be extracted by a new process invented by the noted German chemists, DR. FRANZ FISCHER of the Coal Research Institute at Mülheim. Dr. Fischer's process consists in passing the gas through sewage sludge, which swarms with bacteria. These remove the carbon monoxide and recombine the carbon with hydrogen, returning it to the gas as methane, which has a high fuel value and is not poisonous.—*Science Service*

ZINC REFINED BY NEW PROCESS

A revolutionary new process for producing metallic zinc of unusual purity

from the concentrated ore, which is expected to find wide application because of its economies, has been developed by the U. S. Bureau of Mines.

In the new process natural gas, which is plentiful in most of the states where zinc is mined, replaces coal that is expensive because it has to be hauled a great distance. The chemical reaction that changes the impure zinc oxide to the metal takes place at a much lower temperature than in the old clay retorts, so that plant maintenance expense is greatly reduced. The new process can also be made continuous whereas the one in practice now is intermittent.

Officials of the Bureau of Mines do not say just how much cheaper the new process will be, but it is obvious that a great saving will be effected.

The development was described to zinc miners and engineers at the meeting of the American Zinc Institute in St. Louis by R. S. DEAN, chief engineer of the Metallurgical Division of the Bureau of Mines. It was devised by CHARLES G. MAIER, metallurgist at the Pacific Experiment Station of the Bureau located in Berkeley, California.

Mr. Maier first showed by mathematical calculation that pure zinc could be obtained from the ore by methods better than current practice. He then proved in the laboratory that his theoretical reactions were correct. Next, an experimental zinc smelting plant employing the new process was set up in the Rare and Precious Metals Experiment Station at Reno, Nevada, in which the method worked out by theory was tried on a practical scale and found to be successful. —*Science Service*

FARADAY CELEBRATIONS 1931

The Royal Institution of Great Britain, 21 Albemarle Street, London, W. 1, has furnished the following information regarding the Faraday Celebrations this year.

Date of the Centenary

In 1831 MICHAEL FARADAY began, or rather resumed in his laboratory at the Royal Institution, experiments on the induction of electric currents; and on August 29, 1831, made the discovery in which lies the origin of the dynamo and starting point of the utilization of electric power for the purposes of man. On that day, as his diary shows, he wound two coils of wire on to opposite sides of a soft iron ring, connected one coil to a battery and the other to a galvanometer, and at "make" and "break" of the battery circuit observed deflections of the galvanometer connected in the other circuit. From this simple experiment, and the variations of it made by Faraday in succeeding trials, have grown in the past hundred years the science of electrical engineering and the great electrical industry in all its phases as we know it today. No other experiment in physical science has been more fruitful in benefit for mankind. August 29, 1931, is then the centenary of one of the great events in the history of the world.

Organization of the Celebrations

It is fitting that the lead should be taken by the Royal Institution in the arrangement of the celebrations, for it was to the House of the Institution in Albemarle Street that Faraday came in 1813, a youth of twenty-two, to become assistant to SIR HUMPHRY DAVY, who was then the professor of chemistry; where later he succeeded Davy, and where he lived and worked and gave his famous lectures throughout his active life. Faraday took up the work begun by Davy, and established in the Institution the tradition of scientific research and exposition of the highest type, which has been followed in it down to the present day.

It is no less fitting that the Royal Institution should have, in the arrangements for 1931, the assistance of the Institution of Electrical Engineers, the body representing in this country the

profession and industry which owe their existence largely to Faraday's greatest discovery. The two institutions have therefore joined forces in making the plans, and they are indebted to a number of other societies and organizations for their courtesy and coöperation. The Royal Society will entertain the delegates to the Celebrations; the British Association for the Advancement of Science has arranged the dates for its Centenary meeting in London, also in 1931, in consultation with the Joint Committee for the Faraday Celebrations; the Federal Council for Chemistry will participate in the arrangement of the Faraday Exhibition, for Faraday's chemical researches, his isolation of benzene, and his establishment of the laws of electrochemistry, are hardly less remarkable than his purely electrical discoveries. Government, university, and scientific interests have joined in offering their coöperation and assistance to make the celebrations worthy of the occasion.

Provisional Program and Dates

The following program has received the provisional approval of the Managers of the Royal Institution and of the Council of the Institution of Electrical Engineers:

MONDAY, SEPTEMBER 21, 1931

Afternoon: *Reception of Delegates* in the Lecture Theatre of the Royal Institution. It is hoped to invite representative institutions throughout the world to send delegates to the Celebrations.

Evening: *Faraday Commemorative Meeting* at the Queen's Hall, at which addresses will be given on Faraday's work.

TUESDAY, SEPTEMBER 22

Morning: Summer Meeting of the Institution of Electrical Engineers begins with Joint Conference of the Institution and allied Associations.

Afternoon: Visits and Social Functions.

Evening: Royal Institution: Conversazione at the House of the Institution.

Institution of Electrical Engineers: Conversazione and Faraday Exhibition at the Albert Hall.

WEDNESDAY, SEPTEMBER 23

Morning: Opening of the Faraday Exhibition to the public. I.E.E. Summer Meeting and Conference continues.

Evening: [Opening Meeting of the British Association at the Central Hall, Westminster.]

Faraday Exhibition

The principal responsibility for the arrangement of the Faraday Exhibition has been undertaken by the Institution of Electrical Engineers. The central feature of the Exhibition, which will be held at the Royal Albert Hall, and will be open to the public for a period of about ten days from September 23, will be reproductions and illustrations of Faraday's actual experiments, prepared by the Royal Institution, and including a display of some of the historic apparatus. The Institution of Electrical Engineers, the Federal Council for Chemistry, and the representative organizations of the electrical and chemical industries coöperating with them, have undertaken to illustrate by means of special exhibits the full development of electrical and chemical science and industry in all branches which have their origin in Faraday's work. Thus will be demonstrated in a unique manner the full fruition of the work of one of the world's greatest natural philosophers.

Broadcasting

Preliminary conversations with the British Broadcasting Corporation have taken place, and it is expected that arrangements will be made to broadcast the Commemorative Meeting at the Queen's Hall.

Publication of the Diary

Throughout his life Faraday kept a careful diary, in his own hand, of all his experimental work. On his death these "Experimental Notes" were bequeathed to the Royal Institution, and for over sixty years have been its most treasured possession. Although the philosopher himself made extensive use of it in the preparation of his published works, the diary itself has never been published, and to mark the forthcoming Centenary the Managers of the Royal Institution have resolved to publish it in full. The work is now in course of preparation. It will be issued on behalf of the Institution by Messrs. G. Bell & Sons, Ltd., York House, Portugal Street, London, W. C. 2. It is intended to

Aug. 29th, 1831.

1. Experiments on the production of Electricity from Magnetism, etc., etc.

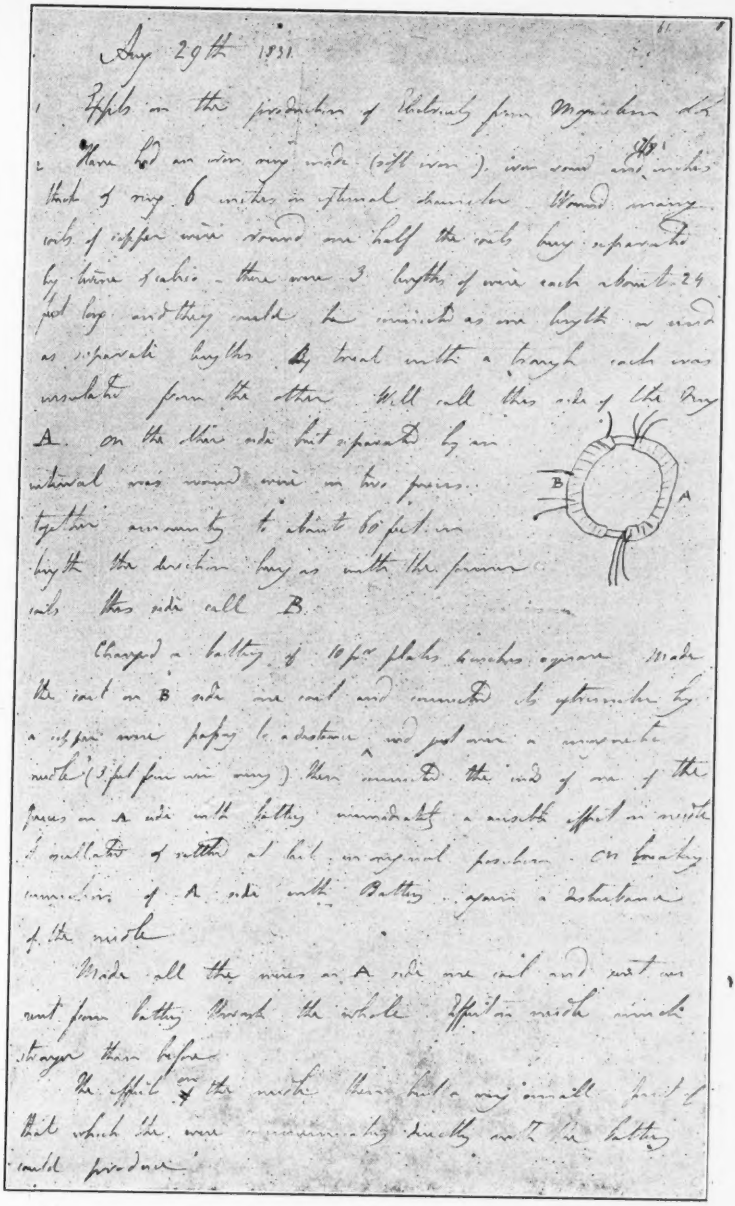
2. Have had an iron ring made (soft iron), iron round and $\frac{7}{8}$th inches thick and ring 6 inches in external diameter. Wound many coils of copper wire round, one half the coils being separated by twine and calico—there were 3 lengths of wire each about 24 feet long and they could be connected as one length or used as separate lengths. By trial with a trough each was insulated from the other. Will call this side of the ring A. On the other side but separated by an interval was wound wire in two pieces together amounting to about 60 feet in length, the direction being as with the former coils; this side call B.

3. Charged a battery of 10 pr. plates 4 inches square. Made the coil on B side one coil and connected its extremities by a copper wire passing to a distance and just over a magnetic needle (3 feet from iron ring). Then connected the ends of one of the pieces on A side with battery; immediately a sensible effect on needle. It oscillated and settled at last in original position. On *breaking* connection of A side with Battery, again a disturbance of the needle.

4. Made all the wires on A side one coil and sent current from battery through the whole. Effect on needle much stronger than before.

5. The effect on the needle then but a very small part of that which the wire communicating directly with the battery could produce.

FACSIMILE AND TRANSCRIPT OF THE PAGE FROM FARADAY'S DIARY



Aug 29th 1831

Effects in the production of Electricity from Magnetism &c

Have had an iron ring made (soft iron) iron round and inches thick of ring 6 inches in internal diameter. Wound many coils of copper wire round one half the coils being separated by twine from each. There were 3 lengths of wire each about 24 feet long and they could be connected as one length or used as 3 separate lengths. By trial with a length each was insulated from the other. Will call this side of the ring A. On the other side but separated by an interval was wound wire in two pieces together amounting to about 60 feet in length the direction being as with the former coils. This side call B.

Charged a battery of 10 pr plates 4 inches square. Made the coil on B side one coil and connected it to galvanometer by a copper wire passing to a distance and got over a magnetic needle (3 feet from ring) then connected the end of one of the pieces on A side with battery immediately a sensible effect on needle & oscillation of nothing & but original position. On breaking connection of A side with Battery gave a disturbance of the needle.

Made all the wires on A side one coil and sent current from battery through the whole. Effect on needle much stronger than before.

The effect on the needle there but a very small part of that which the wire in connection directly with the battery could produce.

have two or more of the six or eight volumes, in which the work will ultimately be completed, ready by September, 1931. A facsimile and transcript of of the page of the diary recording the discovery of electromagnetic induction, referred to above, is reproduced on pages 1444-45.

Other Publications

The preparation of a souvenir of the Celebrations is under consideration, and this may contain excerpts and facsimile pages of important passages from the diary. It is hoped also to issue the addresses at the Commemorative Meeting in printed form; and to publish a Catalog and description of the Faraday Exhibition.

A Tribute to Michael Faraday

"A Tribute to Michael Faraday," by ROLLO APPLEYARD, has just been published by Constable & Co., Ltd., London, 1931. (Pp. xiii + 204 + 21 plates. Price 7s. 6d. net.) A review of this book by HENRY E. ARMSTRONG appears in *Nature*, **127**, 395–7 (March 14, 1931).

ROYAL INSTITUTION MEETING DEVOTED TO JOSEPH PRIESTLEY

The Friday evening discourse on April 24 at the Royal Institution was given by SIR PHILIP HARTOG, on "Joseph Priestley." Sir Philip pointed out that Priestley was one of the most conspicuous figures in the eighteenth century, and has always seemed puzzling to his scientific biographers. Some of Priestley's best work is contained in his "History of Electricity" and his electrical papers, which have been very largely overlooked. He discovered that charcoal, black lead, and red-hot glass are conductors, suggested that there was a gradation of substances from the most perfect conductors to the most perfect non-conductors, and tried to measure conductivity. He anticipated Cavendish and Coulomb, by showing from an experiment of Franklin, elaborated by himself, that the attraction between quantities of electricity varies inversely as the square of the distance. Priestley initiated a new era in chemistry by increasing the number of known species of gas from three to twelve, and paved the way for the revolution effected by Lavoisier. His discoveries of the action of living animals on air, of oxygen on blood, and of the green matter of plants on air under the influence of light, have been of the greatest importance in animal and plant physiology. Finally, it appears from notes for a lecture in the Royal Institution in 1810 that it was a theorem of Newton's and certain observations of Priestley on the diffusion of gases that led Dalton to his atomic theory. Priestley's place in the history of science has been underestimated. There have been greater men of science than Priestley, but few whose discoveries have produced so rich a harvest.—*Nature*

HUGE ELECTRO-MAGNET INSTALLED AT UNIVERSITY OF LEIDEN, HOLLAND

A huge electro-magnet weighing fourteen tons, about two-thirds as much as a street car, just erected in Leiden, Holland, by the Siemens-Halske Company of Berlin, will enable scientists to wrench atoms apart as never before. This marks the realization of a dream of the late DR. H. KAMMERLINGH ONNES, the first man to liquefy helium, who designed the magnet.

The joint action of intense magnetic force with intense cold is likely to yield new secrets about atoms, is the belief of Prof. Onnes' successor, PROF. W. J. HAAS, who completed the work. DR. PETER KAPITZA, of the University of Cambridge, England, has recently constructed a similar magnet for use at extremely low temperatures, with the same hope in mind.

Possible disruption of the windings, endangering the lives of investigators using the super-magnet, has been carefully guarded against by protective

automatic switches. This danger arises when the 80-kilowatt current is suddenly decreased. A rapid lowering of the current produces a sudden removal of the magnetic field and this in turn creates very high induced voltages in the coils of the magnet. Visible and audible signals indicate the operation of the automatic switches.

The huge magnet can be rotated horizontally or tilted vertically with great ease and the great magnetic force made by it can be concentrated in a space of a few inches.—*Science Service*

SAMUEL WILSON PARR

SAMUEL WILSON PARR, president of the American Chemical Society in 1928,

retired professor of chemistry at the University of Illinois, and founder of the Parr Calorimeter Company, died at his home in Urbana on May 16, at the age of seventy-four. Doctor Parr had been ill for a number of weeks. He had been stricken with a blood clot in the heart muscle, but appeared to be making substantial progress.

Doctor Parr was a member of the class of 1884 at Illinois, received his master's degree at Cornell the following year, and later studied at Berlin and Zürich. He began his career as a teacher at Illinois College, but from 1891 until his retirement, because of the age limit, he was a member of the faculty of the University of Illinois. He was known best as a teacher and for his research on the composition, weathering, and spontaneous combustion of coals, the calorimetry of fuels, metallurgical chemistry, work with boiler waters, the invention of platinum substitutes and acid-resisting alloys, studies with potash shales of Illinois, and in recent years for his research on the low-temperature carbonization of coals, particularly those of the State of Illinois.

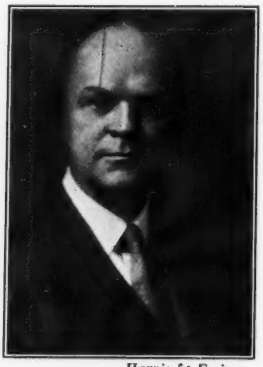
Doctor Parr was a commanding figure. He was prominent in a number of scientific societies. On the occasion of meetings of these organizations he could always be found the jolly center of an interested group, and when he traveled he met everywhere old students and friends who rushed up, happy to see him. He performed good service for the American Chemical Society. His counsel was often sought and freely given. He combined kindness with firmness and habitually displayed an enthusiasm that added to his joy of living. As a past president of the society, an extended account of his life and work will appear in due course in the *Journal of the American Chemical Society*. —*News Ed., Ind. Eng. Chem.*

HUDSON RECEIVES HILLEBRAND PRIZE

CLAUDE S. HUDSON, professor of chemistry at the National Institute of Health, received the Hillebrand Prize of the Chemical Society of Washington at a special dinner meeting held March 26. The prize is awarded each year for the most meritorious contribution to chemical science made by a member of the local section. Doctor Hudson received this recognition for a paper presented before the society on "The Ring Structure of Sugars," which gave in detail the methods

of synthesizing and structural determination of many varieties of sugars.

The Hillebrand Prize award was founded in 1925 in memory of W. F. Hillebrand, late chief of the division of chemistry, U. S. Bureau of Standards. The former recipients of the prize are R. F. JACKSON, G. W. MOREY, E. P. BARTLETT, and J. H. HIBBEN.



Harris & Ewing and Ind. Eng. Chem.

CLAUDE S. HUDSON

As part of the presentation ceremonies held at the Cosmos Club, PHOEBUS A. LEVENE, of the Rockefeller Institute of Medical Research, gave an address in honor of Doctor Hudson on "Sugars in the Service of Chemistry," and E. T. ALLEN, of the Geophysical Laboratory, spoke on "Doctor Hillebrand as I Knew Him."—*News Ed., Ind. Eng. Chem.*

MECHANIST PHILOSOPHY UPHELD BY LEVENE, GIBBS' MEDALIST

Faith in the mechanistic viewpoint, which holds that life can be interpreted in terms of chemistry and physics, was reasserted in Chicago, May 22, by DR. P. A. LEVENE, of the Rockefeller Institute for Medical Research, New York City, in an address following the presentation to him of the Willard Gibbs Medal, one of the highest honors in the field of chemistry. Dr. Levene's subject was "The Revolt of the Biochemists."

Belief in a special and definite life force is, in Dr. Levene's opinion, obstructive to the exercise of that human curiosity which results in the building of scientific knowledge. Against this restriction biochemists began their revolt over a century ago by synthesizing various compounds which had hitherto been thought of as possible only by biologic action. Although the construction of organic compounds has not gone to the full extent prophesied by sanguine chemists a few years ago, nevertheless the results so far achieved are gratifying and full of promise for the future, Dr. Levene said.

The speaker called especial attention to two recent triumphs of biochemistry. One is the discovery of the chemically simple nature of some of the "vital compounds," such as enzymes. These turn out in many cases to be less complex than the compounds they control in the living tissue—they are, indeed, often merely their degeneration products.

The second triumph of biochemistry is the conquest of "directive force" in the test tube. This enables the chemist, by means of controlling his media, to compel a reaction to take one of several possible courses. This is something hitherto reserved to the action of living organisms or cells.

Regarding this, Dr. Levene said: "It is not important that as yet this phase of our knowledge is limited. The significant thing is the formulation of the problem. Its solution is a matter of routine, a matter of the ordinary ingenuity of the human mind. Granting that the problem of the directive force will be solved, it may also be granted that the entire mystery of life will not be solved by this achievement. Chemistry, however, is already preparing a new attack. A more essential characteristic of living matter than the directive force of individual chemical reactions is the power to coördinate all chemical reactions in such a way that the organism may function as a whole for the purpose of maintaining its normal equilibrium and for the purpose of growth and reproduc-

tion. This may be regarded as the integrating force of the living organism."—*Science Service*

DR. HOPKINS LECTURES ON PURIFICATION OF RARE EARTHS

The discoverer of the rare earth, illinium, the last of the chemical elements to be isolated, DR. B. SMITH HOPKINS, of the University of Illinois, described recently the methods which the chemists are using to separate the rare earth elements. The talk was delivered in connection with the American Philosophical Society meeting in Philadelphia and broadcast through the stations of the Columbia Broadcasting System, under the auspices of *Science Service*.

"One of the most puzzling problems in purification, in the field of inorganic chemistry," said Prof. Hopkins, "is furnished by the group of elements commonly known as the rare-earth group." The ores in which this group occurs, and in which illinium was discovered, contain from fifteen to twenty or more elements all closely similar in their properties. A chemical element is one of these ultimate building stones of matter that cannot be broken down into simpler substances.

"Most of the members of the group have been prepared in a satisfactory state of purity only as a result of long, painstaking, and patient effort. With this situation in mind it is easy to understand why illinium, which appears to be the rarest member of the group if not one of the rarest elements now known, escaped detection for so many years."

The close similarity in chemical behavior of the members of this family is in fact the cause of the difficulty in separating them. The only possible methods of doing this depend on the gradual, though slight, change in the solubility and chemical activity of the compounds of these metals as we proceed in regular order from the first to the last member of the group.

"By repeating the process of fractional crystallization many hundreds of times, the original mixture of salts may be divided into a series of fractions, each one of which differs somewhat in composition from that of its neighbors.

"To the worker in the field of the rare earths there is the conviction that perhaps this group holds the key by which we may be able to unlock the storehouse of information of the whole periodic system of the chemical elements."—*Science Service*

AWARD OF J. T. BAKER CHEMICAL CO.'S ANALYTICAL FELLOWSHIP, EASTERN DIVISION

The J. T. Baker Chemical Company's Analytical Fellowship, Eastern Division, has been awarded to MR. NELSON ALLEN for the academic year 1931–32, to work at Princeton University.

Mr. Allen received the B.S. degree from Centre College, Kentucky, in 1927 and the M.S. degree from the University of Chicago in 1929, and is now assistant professor at Centre College. He is the author of a recent paper on the "Quantitative Determination of Small Amounts of Hydrogen Peroxide and Ozone."

The Committee of Award for the Baker Eastern Fellowship is:

PROFESSOR G. P. BAXTER, Harvard University; PROFESSOR P. E. BROWNING, Yale University; PROFESSOR E. M. CHAMOT, Cornell University; PROFESSOR H. A. FALES, Columbia University; and PROFESSOR N. H. FURMAN, Princeton University.

For the conditions under which this fellowship was awarded, consult the J. CHEM. EDUC., **8**, 366–8 (Feb., 1931).

AWARD NOT MADE IN MUSTARD GAS CONTEST

The prize* offered by the International Committee of the Red Cross at Geneva for a reagent to detect small amounts of deadly mustard gas in the air has not been

* See J. CHEM. EDUC., **7**, 108 (Jan., 1930); **8**, 995–6 (May, 1931).

awarded, it has just been announced. The jury of chemists found none of the submitted reagents satisfactory.

According to the terms of the contest, the reagent should have been able to detect with certainty less than one grain of the gas in about one quart of air (0.07 mg. in 1 liter). The amount of the prize was 10,000 Swiss francs, about $2000. The contest closed last December and the jury has since then been considering the reagents submitted with their methods of use. These were known to the jury only by number, the names of the authors being kept separately.

All the methods and reagents were examined in detail. Nine were eliminated at the first examination. The remaining four were made the subject of control experiments. The results were not sufficiently conclusive and the jury decided it could not award the prize offered by the Committee.

The jury consisted of the following: PROF. G. URBAIN of the Sorbonne, director of the Chemical Institute of the University of Paris, *president;* PROF. F. HABER, member of the Berlin Academy; PROF. F. SWARTS, of the University of Ghent, member of the Belgian Royal Academy of Sciences; SIR WILLIAM POPE, professor at Cambridge University, member of the British Royal Society; DR. H. ZANGGER, professor at the University of Zürich, director of the Institute of Legal Medicine of Zürich; and PROF. DEMOLIS, technical advisor of the International Committee of the Red Cross.—*Science Service*

MILLIKAN HAILS RADIO AS FRIEND OF FREEDOM

Radio was hailed as a powerful friend of democracy and freedom, brought into being through science, by PROF. ROBERT A. MILLIKAN, director of the Norman Bridge Laboratory of the California Institute of Technology and president of the National Advisory Council on Radio in Education. Prof. Millikan spoke in Los Angeles, May 22, in the first of the "Men of America" radio addresses, given under the auspices of the Council, over the networks of the Columbia Broadcasting System and the National Broadcasting Company. Prof. Millikan was introduced by PRESIDENT HOOVER, speaking from the cabinet room of the White House in Washington.

Before entering upon a history of the long series of scientific developments that finally resulted in the development of radio, Prof. Millikan raised the question, "What is its significance for the future of mankind?" and answered it himself:

"The Greek republics succeeded so long as they were closely knit city-states; as far-flung empires they disintegrated. The world's first far-flung republic, the United States, has held together for 150 years; but not without proof enough of the difficulties of the task. With every one of its 120 million inhabitants now brought by the radio within an easy range of a single voice for the purposes of instruction, entertainment, and persuasion, as were the free citizens of Athens when they gathered around the Acropolis to listen to Pericles; the task will certainly be henceforth an easier one. The possibility of letting the whole population of the country, in so far as it desires to do so, listen together not only to the best music the country has to offer, but to the spoken words of the leaders of thought in all phases of our American life, is one that is fraught with unmeasured values for our future.

"That possibility of course carries with it also that of the use of the radio by the demagogue and the propagandist, but this precise situation is inherent in all democracy, indeed, in every type of variant of the effort to replace the rule of bullets by the rule of ballots where the ballots are possessed by any large or even any appreciable fraction of the population. Theoretically and historically the ballot type of government can and does work wherever the electorate is reasonably homogeneous, literate, and sufficiently educated to exercise some independence and discrimination of judgment.

"The radio is obviously one of the great

new unifying and educational forces, which can be and should be one of the great factors in insuring the success of ballot governments the world over. If you do not believe in it because you fear its use by the demagogue and the propagandist, then you despair of the ultimate success of widespread ballot governments as such, and you can logically join one of the two world groups, the Soviets, and in somewhat lesser degree the Fascisti, which with Moslem fanaticism are just now exerting the last ounce of energy in them to push the world back along the path of progress, up which it has painfully worked its way for four thousand years, back to the time when the Pharaoh under the strategy of his prime minister, Joseph, became an absolute despot, owning all the property and all the people of Egypt. That kind of philosophy is, of course, repugnant to all the instincts and traditions of every free people."—*Science Service*

DR. LUCKHARDT SPEAKS BEFORE GORGAS MEDICAL SOCIETY, UNIVERSITY OF ALABAMA

DR. ARNO B. LUCKHARDT, discoverer of ethylene anesthesia, professor of physiology at the University of Chicago, delivered two lectures under the auspices of the Gorgas Medical Society at the School of Medicine, University of Alabama, Tuscaloosa, Alabama. The first lecture delivered Thursday, May 17, was on: "The Parathyroid Glands, Their Pathology and Physiology." The second lecture delivered on Friday, May 8, was on: "High Lights and Shadows in the History of the Discovery of General Anesthesia."

After the close of the second lecture Doctor Luckhardt was made an Honorary Fellow in the Gorgas Medical Society.

SOUTH DAKOTA ACADEMY OF SCIENCE

The sixteenth annual meeting of the South Dakota Academy of Science was held at Eastern State Teachers' College, Madison, S. D., May 8–9. A number of papers giving the results of original investigation in the various sciences were read on both days of the meeting.

DR. WILLIAM A. RILEY, chief of the department of entomology and economic zoölogy of the University of Minnesota, gave two addresses on the subjects, "Warfare of Man with Insects" and "Some Native Parasites."

The officers of the Academy for the year 1931-32 are:

President, B. B. BRACHETT, University; *First Vice President*, GEORGE GILBERTSON, State College; *Second Vice President*, RALPH E. DUNBAR, Dakota Wesleyan University; *Secretary-Treasurer*, A. L. HAINES, University.

NEW DIRECTOR OF RESEARCH FOR CENTRAL SCIENTIFIC COMPANY

DR. M. N. STATES has resigned his professorship in physics at the University of Kentucky to accept the directorship of research and development of Central Scientific Company, succeeding DR. P. E. KLOPSTEG who became president of that company a year ago. Dr. States assumes his new duties at the close of the present school year.

LOUISIANA SECTION, A. C. S., DEVOTES MEETING TO STUDY OF CHEMICAL EDUCATION PROBLEMS

The Louisiana Section of the American Chemical Society set aside its April meeting to be devoted to chemical educational problems, in accordance with the suggestions of the Division of Chemical Education of the A. C. S. and incorporated in a report of one of its committees. In order to make the meeting as interesting as possible the program committee in charge decided to have a general paper of interest to the entire membership, followed by several short papers dealing with matters of educational interest. This idea proved meritorious as was evidenced by the large attendance of regular members of the section along

with a splendid representation of teachers of chemistry from New Orleans and outlying cities.

The meeting was held on Friday night, April 17, in the Lecture Hall of the Richardson Chemistry Building, Tulane University.

The program offered on this occasion was as follows:

1. *Technical Paper:* "Some Typical Research Problems in Paper Manufacture," by R. H. STEVENS, Bogalusa Paper Co.
2. *Educational Papers:* (*a*) "Some of the Features Affecting the Articulation of High-School and College Chemistry," by MISS VIOLET KELLER, Baton Rouge High School, Baton Rouge, La.
   (*b*) "Some Practical Applications of Methods in Teaching Secondary Chemistry," by MR. T. A. OLIPHANT, Bolton High School, Alexandria, La.
   (*c*) "A Novel Method of Handling Laboratory Work in High-School Chemistry," by DR. T. R. RUDOLF, Warren Easton High School, New Orleans, La.
   (*d*) "Presenting the Metals in Elementary Courses," by MISS ETHEL WILLIA PERKINS, Wright High School, New Orleans, La.

AMERICAN ASSOCIATION OF PHYSICS TEACHERS

The first regular meeting of the *American Association of Physics Teachers* was held at the Bureau of Standards in Washington on Thursday, April 30. The meeting was addressed by DR. ALBERT W. HULL, assistant director of research at the General Electric Company, on the subject, "Qualifications of a Research Physicist." The discussion was led by PRESIDENT KARL T. COMPTON of Massachusetts Institute of Technology. The attendance was about six hundred.

A dinner and business meeting was held in the evening at which there was general discussion of the plans of the organization. The first annual meeting will be held in New Orleans in connection with the meetings of the A. A. A. S., probably on December 31. The programs for this meeting are being arranged by the executive committee. Application has been made for affiliation with Section B of the A. A. A. S.

The association, which was organized at the Cleveland meeting, now numbers four hundred members. The campaign for increase of membership is continuing. Applications received prior to June 1 will result in enrolment of the applicant as a charter member. The secretary of the Association is PROFESSOR WILLIAM S. WEBB, University of Kentucky, Lexington, Ky.

CHEMICAL EXPOSITION MEETING OF THE NEW YORK PROFESSIONAL GROUP OF ALPHA CHI SIGMA

The Chemical Exposition Dinner of the New York Professional Group of Alpha Chi Sigma Fraternity on the evening of Wednesday, May 6, was one of the most successful events of the Thirteenth Exposition of Chemical Industries. One hundred and thirty-three members of the fraternity from all parts of the country dined together in the New England Room of the Prince George Hotel on that occasion.

DR. FRANK C. WHITMORE, Omicron, acted as toastmaster, introducing the speakers by describing their peculiar and unsuspected hobbies.

DAVID A. MCLEAN, Eta, president of the New York Professional Group, welcomed the visiting members and expressed the hope that this function might continue as a biennial occasion for the New York brothers to greet the fraternity at large.

The speakers mentioned and described those phases of the Chemical Exposition which were particularly interesting to them.

DR. HARRISON E. HOWE, Alpha Beta, spoke of the industrial advances which

were to be seen at the Exposition and of the particular prominence to which plastics and alloys have risen at this exhibit. He issued a warning to chemists when he said that research was advancing more rapidly than industrial progress and that some manufacturers were beginning to consider the expense of research as a necessary evil.

DR. LAWRENCE V. REDMAN, Kappa, spoke regarding the ideals of and the differences between western and eastern civilizations. To the eastern civilizations we are indebted for five of our great religions and but little development of the sciences. On the other hand our western civilizations have produced the great advances in science and have produced no great religion. The civilizations have conquered and dominated each other at various periods in history. Our mental habits are a result of this combat between eastern and western civilizations. Dr. Redman closed with a plea that we who have our western science should not neglect the spiritual and fraternal side of our lives as well as some of the benefits of the finer eastern philosophies.

MR. RUSSELL S. MCBRIDE, Beta, mentioned the differences to be observed in the attitude of the exhibitors at this Chemical Show from some previous exhibitions. The fairness with which the greater number of exhibitors discussed their products and the absence of great sales talks and greater sales arguments distinctly characterized this above all other Expositions in the past.

DR. HARRY A. CURTIS, Eta, summarized the impressions of the exhibit which the speakers before him had received and then spoke of the great work and service being accomplished by the Student Courses at the Expositions.

DR. STROUD JORDAN, Rho, repeated and emphasized some of the great advances that have been made in industrial apparatus and the new materials available for their construction. In a time of industrial depression such as this, he said in concluding, we should take stock to see what we as chemists are doing to add to the enjoyment of life as a whole and to alleviate human suffering.

DR. WILLIAM T. READ, Chi, concluded the talks of the evening with an original humorous negro monolog, "Uncle Billy Looks at Chemists." This was the first appearance of Uncle Billy in some time and he was thoroughly enjoyed by the chemists whom he razzed so unreservedly.

Ice from Mexico. Dry ice, solidified carbon dioxide which does not melt but evaporates, is well known and widely used as a clean, improved substitute for ice. Its production (about 350 tons a day) has been limited, however: its price high (about $100 a ton). Reason, the necessity of manufacturing the carbon dioxide gas synthetically.

Cheaper carbon dioxide solidified may be in the offing. According to news from the Quebracho oil fields in Mexico, the Globe Petroleum Company, while drilling for oil, has discovered an apparently inexhaustible supply of carbon dioxide gas and has installed a plant to solidify it (by reducing its temperature to minus 78°C.) into cubes weighing 45 lb. each.

Three of the Ward Line's steamers in the Tampico-New York service have been equipped to carry 200 tons of these cubes in separate compartments entirely enclosed and insulated with 12-inch walls of cork—the heaviest insulation on record.

This development will be an impetus to the marketing of quick frozen foods.

Students of the history of chemistry will recall that the early nineteenth century was the age of the liquefaction of gases and that Thilorier, after developing a method for the manufacturing of soda water, proceeded further and condensed carbon dioxide (1834). Once when he was experimenting with the gas in the liquefied form, he found that when the liquid was allowed to escape through a jet into a heat-insulated box, a snow-like jet was formed.—*Tech. Review*

Recent Books

A Brief Course in Physics. CHARLES H. LAKE, First Assistant Superintendent of Schools, Cleveland, Ohio; GEORGE P. UNSELD, Head of the Department of Physics, The West High School, Salt Lake City, Utah. D. C. Heath and Co., New York City, 1931. vi + 468 pp. 318 figs. 10 Illustrations. 13 × 19 cm. $1.68.

The aim of the book, as set forth by the authors in the preface, is to present the usual subject matter of an elementary physics course in such a manner as to give the pupil an understanding of the fundamental principles of the science and not merely a mass of facts and formulas, and also to avoid diverting the pupil's attention from these principles by numerous descriptions of the ever-multiplying mechanical devices.

The introduction includes explanations and definitions of many of the fundamental terms such as matter, space, motion, mass, force, and energy, without which an understanding of physics is impossible.

A unique feature of the book is the provision made in the early pages for a thorough review of the simple mathematical processes which are involved in the solution of standard physics problems. The formulas for the area and circumference of a circle, the volume of a sphere and the like, are given in addition to a set of problems involving percentage, decimals, square root, and the solution of equations in one unknown. Many of the later sections are followed by a page or two of "Mental Arithmetic." The problems are given in the form of sentences to be completed and should be of considerable value to the student. The number of numerical problems of the older type is somewhat too small. A series of non-numerical questions on each chapter is provided at the back of the book.

The space allotted to sound is about one-half that given by most textbooks. The essentials are included but the statement is brief and less than the normal attention is given musical instruments and scales. The treatment of heat is also brief. There is no separate section entitled "Light" as in the older textbooks. The essential facts concerning light are included in the section entitled "Radiation." The authors have departed entirely from the usual procedure by introducing the discussion of magnetism after electrostatics and current electricity and its chemical production have been taken up. Magnetism is thus more closely linked with the discussion of the electromagnetic production of current.

Those topics which were formerly left for the last few pages of the textbook have become an integral part of the subject matter from the beginning. The student is not confronted by a mass of isolated theories which, to him, seem contradictory to those which he has already learned. A simple and clear explanation of the recent theories of the structure of matter is introduced in the first chapter and developed throughout the book. The photoelectric effect and quanta are introduced at the logical point. Spectra are explained in terms of the passage of electrons from one stationary state to another and spectral series are presented in an understandable manner. The Bohr atom is also given considerable space.

The book meets a great need by presenting this type of material in so able a manner and should be very stimulating. The presentation of mechanics, heat, and sound, however, leaves something to be desired.

GRACE HOOPER

GREENWOOD SCHOOL
RUXTON, MARYLAND

Teaching the Bright Pupil. FAY ADAMS, Supervisor of Student Teaching and In-

structor in Education, University of Southern California, and WALKER BROWN, Vice Principal of Bancroft Junior High School, Los Angeles, and Lecturer in Education, University College, University of Southern California. Henry Holt and Company, New York City, 1930. xiv × 249 pp. 12.5 × 18.5 cm. $1.36.

The book under review is "intended as a manual of practical suggestions for teachers, supervisors, administrators, and others who are faced with the problem of making the work of the school interesting and profitable for the bright pupil." There is no wish to "deny the importance of the less-gifted pupils" but it is emphasized that the time has come for a more "definite recognition of the interests of the bright student."

Frank admission is made that the aids suggested are "drawn largely from teachers in junior and senior high schools" and so are valuable as sources of enrichment for the educational experiences of bright pupils in their secondary years.

Starting with an apologetic for a philosophy which recognizes the superior pupil in a democracy, the authors continue with an enumeration of the various characteristics of the bright pupil. After a survey of various means used to identify the bright pupil, a chapter is introduced that considers the general problem of grouping in relation to the successful teaching of these pupils. The extent to which curricula should be altered in ministering to the educational needs of these students is then considered. These general considerations are summarized in a chapter which has a sub-caption "Fundamental Principles of Teaching Rapid-Group Pupils." The last two chapters in the book contain specific applications of these principles, first, to curriculum and, second, to extra-curriculum materials.

The reviewer has found in this one volume an epitome of the philosophy and experience of those working and writing in this field. An added attraction of the publication is that it has focused its attention upon schoolroom practice.

It is to be regretted, however, that the authors have almost wholly ignored the journal publications upon this subject. It is also disappointing to teachers of science to find but eleven pages of suggestions for the enrichment of their teaching, while there are over thirty pages upon the enrichment of English and twenty-five or more given to the social sciences.

Nevertheless the book under review is a desirable addition to the growing literature of this field of education. Especially so because of its contribution to the heretofore but scantily reported experiments of teachers who have been pioneering in this type of curriculum enrichment. Forward-looking teachers of chemistry who are in sympathy with the National Research Council's efforts to locate and nurture the superior chemistry student toward creative fields will find stimulation and aid in this volume.

B. CLIFFORD HENDRICKS

UNIVERSITY OF NEBRASKA
LINCOLN, NEBRASKA

The Conductivity of Solutions. CECIL W. DAVIES, M.Sc. (Wales), A. T. C. Senior Lecturer in Physical Chemistry, Battersea Polytechnic Institute. John Wiley and Sons, Inc., New York City, 1931. viii + 204 pp. 22 figs. 14 × 22 cm. $4.00.

Those interested in the conductivity of solutions have been pleased that in the last years several excellent books and "Handbuch" articles have appeared on the subject. This book will in many ways be found to be the most generally useful of them. For purposes of review it may be divided into two sections—one in which the experimental methods and results are briefly given, and the other in which there are considered some special questions which can be investigated by conductivity studies.

The results of experimental work are discussed with particular reference to the

interionic attraction theory of Debye, Hückel, Onsager, and others. The author points out that the conductivity of a solution will in general be determined by the relative number of ions *and* their mobilities, so that if the mobility changes can be accounted for, a change in the relative numbers of the ions, that is, *a* degree of dissociation, may be calculated. The interionic attraction theory makes this possible because according to it conductivity changes are attributed entirely to the effect of interionic forces on the mobilities of the ions. There are also chapters in which relationships between conductivity and viscosity, methods of determining the equivalent conductivity at infinite dilution, and temperature effects are considered.

Among the problems considered which may be investigated by conductance studies there may be mentioned chemical analysis, dissociation of ternary electrolytes, nature of acids and bases, solvolysis, complex ions, and amphoteric electrolytes. The sections form well-written introductions to these important subjects.

The reviewer is disappointed that Dr. Davies feels "the chemist will judge the Debye-Hückel-Onsager equations not by the manner of their derivation but by the degree of success with which they interpret and predict the results of experiment," and has written his book accordingly. Thus, less than ten pages of a third and introductory section are devoted to a description of the theoretical aspects of the interionic attraction theories and, although the book deals with the conductivity of solutions, only three of these pages may be said to describe the new conductivity theory itself. In this space it is possible to mention only the very simplest notions and to give the final equations, so that a reader does not have clearly before him the assumptions and approximations which have to be made in order to calculate the "period of relaxation" effect (more commonly called the electrical force of relaxation) and the "electrophoretic" effect. The degree to which a theory may be expected to fit experimental fact will depend upon these assumptions and approximations. Again, the author has all too briefly discussed the important theoretical significance of the effect of the application of high field strengths and high frequencies in the measurement of the conductivities. Thus while the stated purpose of the book has been fulfilled to a remarkable extent, the interest of a research worker might have been stimulated to a greater degree by stricter attention to the theoretical details.

This criticism should not be taken as an adverse judgment of the book, for it is primarily concerned with an account of experimental work. It will certainly be welcomed by many persons as a clear, concise, and, at the same time, comprehensive account of the conductivity of solutions.

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The Vitamins. H. C. SHERMAN, Mitchill Professor of Chemistry, Columbia University, and S. L. SMITH, Senior Chemist, Office of Experiment Stations, United States Department of Agriculture. Second edition. American Chemical Society Monograph Series. The Chemical Catalog Company, New York City, 1931. xii + 562 pp. 14 figs. 16 × 20 cm. $6.00.

In the preface the authors state that "an attempt has been made to summarize the very considerable amount of information which has been gained regarding the chemical natures of the individual vitamins, and the more voluminous knowledge regarding their rôles in life processes, their formation and distribution in nature, their relative abundance in different types of food materials and stability under the conditions to which these are likely to be subjected." "Recognizing that knowledge of vitamins touches closely the intellectual and professional interests of many other scientifically trained persons as well as professional chemists,

we have sought to treat the subject with the interests of all probable readers in view, and have thus included more of physiological, pathological, nutritional, and health aspects than would otherwise be expected in a chemical monograph."

The book contains seven chapters, a bibliography, and an author and subject index. Chapter 1 is devoted to the general considerations of the vitamin theory. The remaining chapters are devoted respectively to vitamin B (B_1); vitamin G (B_2); vitamin C; vitamin A; vitamin D; and vitamin E. Our knowledge of each vitamin is developed by an account of the individual researches in chronological order, which have brought to light its existence, effects of deprivation of, its distribution and properties. The subject is presented in the masterful manner to be expected from well-known investigators and teachers. The book is the best source of information on the subject of the vitamins.

The bibliography occupies 184 pages and supplies approximately 3300 titles all of which appear to be selected for their importance rather than for completeness of reference. Complete titles as well as references to the literature are given.

The book will prove interesting and instructive to a wide circle of readers whose interests lie outside the fields of chemistry and the more restricted field of nutritional research. The objectives stated by the authors in their preface in the quotations given above have been achieved in a very creditable degree.

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Structure Symbols of Organic Compounds. INGO W. D. HACKH, College of Physicians and Surgeons, San Francisco. P. Blakiston's Son & Co., Inc., Philadelphia, 1931. viii + 139 pp. 29 plates. 13.25 × 19.5 cm. $2.50.

This book has been designed as an aid to students and teachers of organic chemistry. It consists of three parts: (1) a statement of "the pertinent facts and fundamental concepts of atomic structure"; (2) a development of the "structure symbol," its advantages, its electronic interpretation, and the use of the latter in the prediction of reactions; and (3) a list of the structure symbols of 991 organic compounds and the electronic structure symbols of 30 compounds.

The structure symbol for compounds containing carbon, hydrogen, oxygen, and nitrogen differs from the ordinary structural formula in that no chemical symbols appear in the formula; in other words, it consists of lines only, hydrogen being represented by a point at the end of a line; oxygen, nitrogen, and carbon being represented by points at the junction of two, three, or five, and four lines, respectively. [See J. CHEM. EDUC., 7, 836–41 (Apr., 1930).] The author claims for the structure symbol an advantage over the structural formula in (1) exactness, (2) compactness, (3) accuracy, (4) simplicity, (5) clearness, (6) uniformity, and (7) universality.

The electronic structure symbol is obtained from the structure symbol by the addition of dots which represent electrons. Shared electrons appear on the lines of the structure symbol (or astride it) while the unshared electrons do not. In the case of polar compounds, shared electron pairs are shifted toward the atom having the greatest number of unshared electrons.

The present structural formula seems so well established that it is not likely to be replaced unless a much more desirable method of representation is devised. Any such method will have to overcome custom, and to do this its advantages must outweigh decidedly its disadvantages. The structure symbol does have the advantage of compactness and simplicity, but is that sufficient to overcome the inconvenience of having the chemical symbols omitted? Is it not desirable to make our representation intelligible to, at least, the scientifically interested public? Taking everything into consideration, the re-

viewer does not feel that the structure symbol is an improvement over the structural formula.

The electronic structure symbol is dots and lines; the usual electronic formula is dots and chemical symbols. It is lines versus chemical symbols, with the advantage to the latter, for the electronic formula is not only less confusing but it actually shows without any question which are shared pairs of electrons and which are not.

Careful reading of this work has suggested the following points. The plates of structure symbols are remarkably well done. In a few cases clarity would be gained by a revision of the sentence structure. Empirical formula is applied to what is ordinarily considered the molecular formula. Probably the most interesting topic in the text, "Prediction of Reactions," page 27, is difficult to follow, due to the omission of reaction V, an incorrect reaction X, and the use of numbered arrows, the meaning of which is not readily clear, directly below the structure symbols on pages 28 and 29. And, too, does the author mean to ignore the Crum-Brown-Gibson Rule on pages 30 and 31 when he says that the position which the second substituent in the benzene ring takes depends upon the character of that substituent?

The development in this text is interesting, and doubtless as much good could be gained from its use by the informed as by any other structural representation. The author has pursued the subject at great length and has the satisfaction of having devised a compact, workable system of representation.

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MISCELLANEOUS PUBLICATION

Chemistry of Today. Broadcast Supplement of *The Nucleus*. Published under the auspices of the Northeastern Section of the A. C. S., Inc., P. O. Box 1178, Boston, Mass., March, 1931. 21 pp. 15 × 23 cm.

The Northeastern Section of the A. C. S. has been sponsoring a series of chemical radio talks for the past few months. In this supplement are recorded the following radio addresses already delivered:

"An Introductory Talk," by M. J. AHERN.

"Side-Stepping Nature's Processes," "Chemistry—An Aid to Industry," "The Wizardry of Modern Chemistry," all by GUSTAVUS J. ESSELEN.

"Chemistry and the X-Ray," "Chemistry and Diet," "Chemistry and the Ductless Glands," all by ALLAN WINTER ROWE.

Bibliography of French Technological Works. Fourteen of the leading French publishing firms which specialize in the production of technological literature have combined to produce a "Bibliographie des livres français d'Industrie et de Technologie." The lines of the "Catalog of British Scientific and Technical Books" of the British Science Guild have been closely followed, with the following difference, namely, that books published in 1929-30 precede the General Catalog for 1919–30, which forms the bulk of the work. Entries in Part 1 are annotated; those in Part 2 are not. The name and subject indexes include both sections. Hence there is some danger of confusion, and the writer of the prefatory note wisely counsels the user of the Bibliography to consult both sections "*en cas de recherche.*" An annual supplement to the bibliography is promised with a consolidated edition every third year. The classification and indexing of the entries have been carried out in a workmanlike manner, and we have no doubt that the bibliography will prove a useful guide in the selection of French technological books in all parts of the world.— *Nature*